ARROWHEAD CONTRACTING, INC.

April 27, 2001

Ms. Sandy Olinger (AMSAM-EN)
Building 3206 Redstone Arsenal
Huntsville, Alabama 35898

Draft Sampling and Analysis Plan
Determination of PCB TSCA Waste Quantities
Building 3, St. Louis Army Ammunition Plant
Contract No. DACW41-00-D-0019

Dear Ms. Olinger:

Arrowhead Contracting, Inc. (Arrowhead) is pleased to submit the enclosed draft Sampling and Analysis Plan (SAP) for the Determination of PCB TSCA Waste Quantities at Building 3, Saint Louis Army Ammunition Plant, Saint Louis, Missouri. Please note that the Project Forms (Appendix A) were not included in the draft SAP. These forms will be included in the final SAP.

A distribution list for this document is attached. As per the schedule, persons reviewing this document should submit comments to Ms. Sandy Olinger by May 18, 2001.

If you should have any questions regarding the SAP, please call us at (913) 814-9994.

Sincerely,

Greg Wallace, R.G.
Project Manager

Enclosures:

Cc: See attached distribution list

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DRAFT
SAMPLING AND ANALYSIS PLAN
DETERMINATION OF PCB TSCA WASTE QUANTITIES
BUILDING 3
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

PRE-PLACED REMEDIAL ACTION CONTRACT
CONTRACT NO. DACW41-00-D0019
TASK ORDER NO. 0002

Submitted to:

Department of the Army
U.S. Army Engineer District,
Kansas City Corps of Engineers
700 Federal Building
601 East 12th Street
Kansas City, Missouri 64106

Department of the Army
Aviation and Missile Command
Building 3206 Redstone Arsenal
Huntsville, Alabama 35898

Submitted by:

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April 27, 2001

Sampling and Analysis Plan

This document presents a sampling and analysis plan to support an engineering estimation of the quantity of selected polychlorinated biphenyl (PCB) contaminated material in Building 3 at the Saint Louis Army Ammunition Plant (SLAAP) located at 4800 Goodfellow Boulevard in Saint Louis, Missouri (refer to Figure 1-1 for the location of SLAAP). These activities are being conducted in support of a proposed remedial action for Building 3.

This document was prepared on behalf of the U. S. Army Corps of Engineers (USACE), Kansas City District (CENWK) and the U.S. Army Aviation and Missile Command (AMCOM), Huntsville, Alabama under the Arrowhead Contracting, Incorporated (ACI) Pre-Placed Remedial Action Contract (PRAC) number DACW41-00-D0019, Task Order 0002. This Site Specific Sampling and Analysis Plan (SAP) consists of two parts:

Part I – Field Sampling Plan (FSP)
Part II – Quality Assurance Project Plan (QAPP)

The FSP provides descriptions of the procedures and protocols to be followed during the implementation of the proposed activities. The QAPP provides the quality assurance/quality control guidelines for the collection and analysis of all environmental samples.

This document has been prepared in accordance with the provisions of USACE Engineering Manual (EM) 200-1-3.

Part I - Field Sampling Plan

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

ACI	Arrowhead Contracting, Inc.
AMCOM	Aviation Missile Command
ATCOM	Army Aviation and Troop Command
ATSDR	Agency for Toxic Substances and Disease Registry
AVSCOM	Aviation Systems Command
CENWK	U.S. Army Corps of Engineers, Kansas City District
CENWO	U.S. Army Corps of Engineers, Omaha District
CAR	corrective action request
COC	chain-of-custody
CQAB	U.S. Army Corps of Engineers, Chemistry Quality Assurance Branch of the Waterway Experiments Station Environmental Laboratory
DQCR	Daily Quality Control Reports
DFW	definable feature of work
DoD	U.S. Department of Defense
DQO	data quality objective
EBS	Environmental Baseline Study
EM	Engineering Manual
EPA	U.S. Environmental Protection Agency
FWV	Field Work Variance
FSP	Field Sampling Plan
H_0	null hypothesis
ID	inner diameter
IDW	investigation derived waste
kg	kilogram
mg/kg	milligram(s) per kilogram
µg/l	microgram(s) per liter
mg/l	milligram(s) per liter
mm	millimeter
NCR	Nonconformance Report
NON	Notice-of-Noncompliance
OSHA	Occupation Safety and Health Association
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PRAC	Pre-Placed Remedial Action Contract

List of Acronyms (continued)

QAPP	Quality Assurance Project Plan
QC	quality control
QCP	Quality Control Plan
QMP	Quality Management Plan
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
SHERP	Safety, Health, and Emergency Response Plan
SLAAP	St. Louis Army Ammunition Plant
SLOP	St. Louis Ordnance Plant
sq. ft.	square feet
SVOCs	semi-volatile organic compounds
TCLP	Toxicity Characteristic Leaching Potential
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers

1.0 Introduction

The purpose of this Field Sampling Plan (FSP) is to establish the sampling strategy, sample locations, and the procedures and protocols to be followed during a sampling effort in support of an engineering estimation of the quantity of selected PCB contamination in Building 3. The scope of the sampling activities were developed based on findings and recommendations included in the following documents:

- Final Environmental Baseline Survey Report, Saint Louis Army Ammunition Plant, St. Louis, Missouri (AMCOM, 2000)
- Alternatives Evaluation for Removal of PCBs, Saint Louis Army Ammunition Plant, St. Louis, Missouri (AMCOM, 2001)

This document has been organized into eleven sections. The contents of each section are discussed below.

- Section 1.0 – Introduction
  - Presents an introduction to site history, physical features of the building, current understanding nature and extent of PCB contamination, risk-based cleanup goals, and regulatory drivers.

- Section 2.0 – Project Organization and Responsibilities
  - Identifies organizations, roles, and responsibilities for key personnel to be used during the field activities.

- Section 3.0 – Sampling Program Rationale
  - Presents a sampling strategy based on the data quality objective (DQO) process.

- Section 4.0 – Field Activities
  - This section presents a description of the field activities, the rationale for conducting the activities, the field protocols to be used during the activities, and laboratory analysis for the planned field sampling activities.

- Section 5.0 – Sample Chain-of-Custody/Documentation
  - Presents details regarding sample documentation including field logbooks, sample labels, sample collection field sheets and chain-of-custody.

- Section 6.0 – Sample Packaging, Shipping, and Archiving
  - Presents details regarding sample packaging, shipping and archiving.

- Section 7.0 – Investigation Derived Wastes

  - Presents details regarding handling, storage, and disposal of investigation derived waste.

- Section 8.0 – Contractor Quality Control
  - Presents details regarding contractor quality control.

- Section 9.0 – Field Corrective Actions
  - Presents a discussion of corrective actions for any non-conformances identified in the field.

- Section 10.0 – Project Schedule
  - Presents a schedule for the field and activities and reporting associated with this SAP.

- Section 11.0 – References
  - Presents references that are relevant to the basis of this FSP.

1.1 Site History

In 1941, the St. Louis Ordnance Plant (SLOP) was constructed on a 276-acre parcel of property near what is now the intersection of Goodfellow Boulevard and Interstate I-70. SLOP was constructed to produce 0.30- and 0.50-caliber munitions in support of World War II. In 1944, approximately 21 acres in the northeast portion of SLOP was converted from small arms munitions production to 105-millimeter (mm) Howitzer shell production and was designated as SLAAP. Currently, the SLAAP property consists of eight unoccupied buildings that were used to house SLAAP main operating processes. This study focuses solely on Building 3, also historically referred to as Building 202ABC. The processes completed in Building 3 included shell-shaping, heat-treating, cleaning, painting, and packaging shells for shipment. Following World War II, SLAAP was placed on standby status, only to be reactivated to support the Korean Conflict (from November 1951 through December 1954) and the Vietnam War (from November 1966 through December 1969).

In 1984, Building 3 was renovated to include office space for personnel from the U.S. Army Aviation Systems Command (AVSCOM). The building was occupied in this capacity until 1996. In 1989, the Department of Defense (DoD) determined that SLAAP was no longer needed for munitions support and all industrial equipment was removed from the facilities. Since 1998, Building 3 has been vacant and under the control of AMCOM.

1.2 Physical Features of the Building

Building characteristics, historical uses, historical processes, and hazardous material information for Building 3 are summarized in Table 1-1.

1.3 Current Understanding of Nature/Extent of Environmental Contamination

Oils containing PCBs were used in Building 3 primarily as a coolant in the milling, lathing, and smoothing processes associated with munitions production. PCBs were first discovered in Building 3 in creosote-treated wood flooring blocks during renovation activities in March 1991. The U.S. Environmental Protection Agency (EPA) Region VII was notified of the discovery and, in turn, issued a notice of noncompliance (NON) under the Toxic Substances Control Act (TSCA) in May 1991 (TSCA Docket Number VII-91-304).

The NON stated that the facility was not in compliance with the National Spill Clean-Up Policy for PCBs (40 C.F.R. Part 761.125) and requested documentation of the following four items:

- Evidence of the removal and proper disposal of all contaminated mastic and wood from both floors of Building 3.
- Evidence of the removal and proper disposal of all contaminated plastic and fiberboard from the file storage area.
- Decontamination of all non-porous surfaces to less than 10 micrograms per 100 square centimeters ($\mu g/100\ cm^2$) and verification of the same by submitting results of analyses from post decontamination wipe sampling to this office (EPA Region 7).
- Decontamination of all porous surfaces (concrete) to less than 10 parts per million (ppm) PCBs as determined by destructive sampling (core sampling). Please submit a statistically based sampling plan to this office prior to such sampling and coordinate sampling activity with this office so an inspector can be on-site to witness the activity and obtain split samples for EPA analysis.

Since the NON has been issued, a number of decontamination and confirmatory sampling activities have been conducted at the site. For example, Rust Remedial Services, Inc. (Rust), formerly Chemical Waste Management, Inc., performed decontamination and confirmatory sampling activities for the PCB contamination in Building 3 from September 1991 through August 1994. Decontamination activities included removal of the PCB-contaminated wood blocks, scarification of the concrete floor surfaces, and washing of block walls on the first and second floors of the building. Additional decontamination activities were performed in the

summer of 1996 to remove PCB contamination from the first floor. As part of the remedial approach for Building 3, a health-based risk assessment was completed to determine risk-based cleanup levels for the basement and the first and second floors of Building 3. The risk assessment concluded that residual contamination in the building did not present an unacceptable health impact and that further remediation was not necessary. The Agency for Toxic Substances and Disease Registry (ATSDR) did not endorse the health-based risk assessment. Samples collected from porous (concrete) surfaces and the non-porous (steel) surfaces in support of the risk assessment evaluation indicated residual PCB contamination was still present at concentrations that exceeded federal guidelines.

On August 7, 1997, the U.S. Army Aviation and Troop Command (ATCOM) sent a letter to EPA Region VII documenting its agreement to complete the following tasks for Building 3:

- Paint the walls and ceilings and cap the floor with concrete,
- Isolate the chip chute by constructing a wall in the basement,
- Develop a sampling plan and perform a health risk assessment to be reviewed by the appropriate Army agency,
- Take ambient air samples to measure PCB levels after completion, and
- Meet with EPA Region VII to determine if any future action is needed.

To date, the NON issued by the EPA is still unresolved. EPA has indicated in more recent discussions that the clean-up standards set forth in the 1998 TSCA Amendments (see Section 1.4) supercede the standards as set forth in the NON.

More details regarding each of the decontamination and confirmatory sampling events are provided in the *Final Environmental Baseline Survey Report for the St. Louis Army Ammunition Plant, St. Louis, Missouri, December 28, 2000* (AMCOM, 2000). Finally, in August 1997, ATCOM directed painting of the walls and ceilings and capping of the floors with concrete to prevent exposure to the residual PCB contamination.

Analytical data have been used from the aforementioned decontamination and sampling episodes in an attempt to quantify the levels of residual PCB contamination on each of the floors within Building 3. In general, nature and extent of PCB contamination remaining in Building 3 can be summarized as follows:

- The majority of the PCB contamination within Building 3 is associated with the concrete flooring on the first and second floors (see Figures 1-2 and 1-3). Concentrations range from 2 ppm (detection limit) to 730 ppm (in the area of the former chip chute). The degree to which the PCBs penetrated into the concrete flooring is unknown. Presumably, the depth of PCB penetration is greatest in processing areas where the oils accumulated beneath the oil soaked wood blocks. Many of the remaining areas are likely contaminated at relatively shallow depths, such as the walkways, canteens, and restrooms. Concentrations in these areas are likely attributed to foot traffic from SLAAP personnel.

- The chip chute area where the PCB contamination is present in the walls, flooring, and in a pile of waste material (most likely residual cuttings/shavings from the operation).

- Selected columns in the basement where the PCBs seeped downward from the first floor. There are no data available to characterize the extent and magnitude of this contamination.

- Selected areas of the basement flooring where the PCBs appeared to have leaked through cracks in the first floor. There are no data available to characterize the extent and magnitude of this contamination.

- The location of four transformer vaults in the basement. There are no data available to characterize the extent and magnitude of this contamination.

- Spill areas in the penthouse where PCBs may have leaked from motors. It is assumed that this contamination is confined to a relatively small area and that the depth of contamination is relatively shallow. There are no data available to characterize the extent and magnitude of this contamination.

Various levels of other contaminants such as asbestos, lead, and pesticides have been detected within Building 3 (Tetra Tech, 2000). These other contaminants, however, are considered incidental in comparison to the PCBs and are not considered further as part of this study.

1.4 Risk-Based Cleanup Goals

CENWK has prepared a risk analysis for potential future exposures to PCBs in the building. The analysis was based on the most prevalent PCB contaminant within Building 3 (Aroclor 1248) and established acceptable risk at the 10^{-6} level. Three different receptor scenarios were evaluated including:

- A future industrial worker who works in the building and comes into contact with PCBs on floor and wall surfaces (comparable to the TSCA high occupancy scenario),

- A future industrial worker who spends part of his/her time working in and around the uncovered contaminated soil in the basement of the building (comparable to the TSCA low occupancy scenario), and

- A future demolition worker who is exposed to contaminated concrete debris after the building is demolished at some future date (this scenario is believed to be the most conservative of the scenarios evaluated because it results in significant direct contact with the contaminant).

The risk-based cleanup goals established for each of the aforementioned scenarios are as follows:

- 15 $\mu g/100cm^2$ on concrete surfaces for the future industrial worker,
- 26 ppm in basement soil for the future worker, and
- 16 ppm in concrete for the demolition worker.

As noted above, the risk-based concentration of 16 ppm in concrete for the demolition worker is considered protective of all other reasonable exposure scenarios within the building (eg., office worker, industrial laborer, etc.). EPA Headquarters has not approved these risk assessment values.

1.5 Regulatory Drivers

PCB contamination within Building 3 is subject to the rules and regulations set forth in TSCA, as amended by the "Mega Rule" in 1998. These regulations provide standards governing the distribution of PCB-contaminated items, including acceptable cleanup approaches and standards, disposal requirements, and sampling and analysis protocols.

Section 761.20 of TSCA prohibits the "distribution in commerce of PCBs at concentrations of 50 ppm or greater". Because PCB contamination exists from spills within Building 3 at concentrations that exceed the 50 ppm threshold criterion, the sale of the property is prohibited until those concentrations are reduced to levels deemed acceptable by EPA Headquarters.

Because historical releases of PCB contamination have resulted in concentrations that exceed 50 ppm, all portions of the resulting contamination must be remediated to an acceptable level. Remedial activities may be self-implemented in accordance with regulations set forth in §761.61(a) of TSCA. Under these regulations, cleanup standards are established for porous surfaces (including concrete) as follows:

- High Occupancy Areas: 1 ppm without restriction, 10 ppm with a 10-inch cap, and a surface cleanup standard at 10 $\mu g/100cm^2$.
- Low Occupancy Areas: 25 ppm, or 25-50 ppm if fenced and marked, 25-100 ppm with a 10-inch cap, and a surface cleanup standard at 100 $\mu g/100cm^2$.

It is important to point out that these cleanup standards are applied with regard to all contaminated material. In other words, cleanup of all PCB contamination exceeding the cleanup standards is required, not just those portions that exceed the 50 ppm triggering criterion. An alternate (risk-based) cleanup number that is higher than the aforementioned cleanup standards may be established if deemed by EPA as sufficiently protective (see Section 1.4 for risk-based numbers).

The definition of high and low occupancy areas is provided in §761.3 of the regulations. Consistent with this definition, the first, second, and penthouse floors of Building 3 are considered high occupancy areas while the basement of Building 3 is considered a low occupancy area. The high and low occupancy criterion does not necessarily apply to the transfer of the property.

Contamination that is removed from the site must be handled in accordance with the Bulk PCB Remediation Waste Criteria. Material containing PCBs at 50 ppm or greater must be disposed in a TSCA-permitted facility (or in a landfill at a similar Resource Conservation and Recovery Act (RCRA) facility). Material containing PCBs at concentrations less than 50 ppm may be placed in a municipal or non-industrial, non-hazardous landfill that is permitted to accept low concentrations of PCBs. In addition, Subpart O of the regulation provides a leaching test option to allow the use of solid waste landfills for disposal of PCB-containing waste that are not readily leaching to the environment, i.e., concentrations in leachate less than 10 micrograms per liter ($\mu g/l$).

2.0 Project Organization and Responsibilities

Table 2-1 identifies organizations, roles, and responsibilities for key personnel to be used during the Building 3 characterization project. Off-site analytical services will be provided by a USACE-approved laboratory (to be determined). Quality Assurance (QA) split samples will be analyzed by the USACE laboratory located in Omaha, Nebraska.

3.0 Sampling Program Rationale

The sampling strategy described in this FSP is based on the Data Quality Objective (DQO) process presented in *EPA Soil Screening Guidance: Technical Background Document* (EPA, May 1996). Based on this guidance, a sampling strategy has been developed and organized consistent with the steps of the DQO process:

- State the problem
- Identify the decision
- Identify inputs to the decision
- Define the study boundaries
- Develop a decision rule
- Specify limits on decision errors
- Optimize the design for obtaining data

Each of these steps is discussed below.

3.1 Data Quality Objectives Process

3.1.1 State the Problem

The objectives of the sampling program are to collect sufficient data to:

- Define the area and volume of PCB contamination at concentrations of 50 ppm or greater that may be present in concrete, soil, and waste material at Building 3.
- Determine the chemical composition of the Chip Chute waste pile for evaluating disposal options.
- Provide information for determining the appropriate for disposing waste building materials during a planned remedial action at Building 3.
- Provide information for assessing the health and safety issues associated with disturbance of building materials (i.e. dust) during a planned remedial action at Building 3.

The later three objectives are considered incidental to the first objective since it is the PCB contamination that is driving the remediation of the building. Hence, the remaining portions of this section will address decisions regarding the PCB contamination.

3.1.2 Identify the Decision

The decision to remediate or not remediate concrete, soil, and waste material in Building 3 will be based on whether PCB concentrations in these materials are at 50 ppm or greater. If so, the materials will be remediated. The decision regarding the proper method of disposing building materials and Chip Chute waste pile material is contingent upon the PCB concentration and concentration of RCRA constituents. Decisions related to health and safety requirements are based on the chemical contaminants in the building materials that could potentially expose workers during remedial activities.

3.1.3 Identify Inputs to the Decision

This step in the DQO process requires identifying the inputs to the decision process, including the basis for investigation and the applicable field sampling and analytical methods. The inputs for deciding whether to investigate are based on recent site visits and on information contained in the following documents:

- Existing characterization of the nature and extent of PCB contamination in Building 3 as defined in the Final Environmental Baseline Survey Report, Saint Louis Army Ammunition Plant, St. Louis, Missouri (Tetra Tech, December 2000)
- Alternatives Evaluation for Removal of PCBs, Saint Louis Army Ammunition Plant, St. Louis, Missouri (Arrowhead, March 2001)

For sampling of the selected areas of Building 3, the inputs for deciding whether to investigate include the following:

- The recommended remedy in the Alternatives Evaluation includes removal and disposal of PCB contamination at or in excess of 50 ppm from Building 3. Material containing PCBs at 50 ppm or greater must be disposed in a TSCA-permitted facility (or in a landfill at a similar RCRA facility). Material containing PCBs at concentrations less than 50 ppm may be placed in a municipal or non-industrial, non-hazardous landfill that is permitted to accept low concentrations of PCBs.

- Figures 1-1 and 1-2 depict the most current interpretation of the nature and extent of PCB contamination in the concrete flooring, first and second floor, respectively. The identified areas of contamination in these figures were developed by AMCOM based on statistical sampling data collected by others prior to placement of the concrete cap. These data represent average concentrations within selected areas of the building. Each area was divided into as many as 48 sectors for purposes of the confirmation sampling program. Three sample aliquots (designated A, B, and C) were collected from each sector. All of

the sample aliquots labeled "A" from each sector within an area were composited together and analyzed for PCBs. The aliquots designated "B" and "C" were composited and analyzed in the same fashion. Given this approach, it stands to reason that a measured concentration of 50 ppm within an area would indicate that at least one of the sectors in the area contains PCB contamination in excess of 50 ppm. However, there is less certainty regarding the remaining areas of the building where lower levels of PCBs were measured. For example, it is possible that one or even more of the sectors within these areas could contain PCB in excess of 50 ppm, even though the concentration of the composite sample is less than 50 ppm.

- EBS sampling data, which indicates the concentrations in the concrete (flooring, columns, and walls) and waste material in the chip chute area, exceed 50 ppm.

- General statements in the EBS noting visual oil staining on the concrete columns as well as wipe samples of the column surfaces which indicate the presence of PCBs. Visual oil staining has been observed on columns in the basement. The columns on the first and second are painted and therefore it is not possible to see if any staining is present.

- The reported former presence of four transformer vaults in the basement. There are no data available to characterize the nature and extent of potential PCB contamination in these areas. It is assumed that the transformer may have used PCB-containing oil.

- The report of possible oil leaks from the formers motors located in the penthouse. There are no data available to characterize the nature and extent of this potential contamination.

- A small area of soil contamination located adjacent to Building 3 (near the chip chute area) that was identified in the EBS.

- There were a number of small areas of the basement flooring where oil staining was observed during recent site visits.

- The were a few cracks and small areas in the first and second floors where oil staining was observed during recent site visits.

- The assumed depth of contamination in the concrete floors is based on knowledge of the location of different types of work areas (areas where process activities were conducted, areas where SLAAP's process personnel traveled about the building, and waste storage areas; i.e. the chip chute area). It is suspected that the depth of PCB contamination at concentration in excess of 50 ppm is greatest in the areas where the PCB contamination may have pooled for extended periods of time (i.e. areas where the process equipment was stationed) and in areas where the waste material was stock piled (i.e. the chip chute). It is suspected that PCB contamination at concentrations in excess of 50 ppm in areas exposed to foot traffic, in walls, and in minor spill areas (i.e. areas where transformer and motors were staged) may be relatively shallow (i.e. less than 1 inch). It should be noted that a concrete cap was placed over the original flooring on the second and first floors.

The cap thickness appears to vary from approximately 2 to 4 inches based on visual observation.

3.1.4 Define the Study Boundaries

This step in the DQO process defines the sample population of interest (areas and depths of concern), subdivides areas of concern into manageable units, and specifies temporal or practical constraints on the data collection.

3.1.4.1 Population of Interest

The media of interest includes those materials that contain PCB contamination at concentrations that are equal to or greater than 50 ppm. Based on the discussion above, it is anticipated that the PCB concentration will vary with depth dependent on the type of area and the orientation of the surfaces (i.e. process areas, traffic areas, walls, columns). The depth of interest will also be dependent on the practical limits of the available remedation techniques and safety concerns associated with these techniques. The following criteria are applicable to the selection of sampling depths:

- It is anticipated that the practical depths limits of a partial floor removal is approximately 4 to 6 inches for the first floor (total floor thickness is approximately 16 inches) and approximately 2 inches below the original floor surface for the second floor (total floor thickness is approximately 8 inches). It is suspected that rebar is present in the second floor concrete starting at about 2 inches below the original surface. It is likely that the rebar in the first floor is much deeper. It should be noted that a 2- to 4-inch concrete cap is present throughout both floors. In addition, there are safety concerns regarding stability of the floor if too much of the flooring is removed.

- It is assumed that PCB contamination at concentrations that is 50 ppm or greater in traffic areas is present in only the uppermost inch of flooring below the concrete cap.

- It is assumed that the depth of PCB contamination at concentrations that are 50 ppm or greater in the process areas can be greater than one inch below the original floor surface.

- The depth of PCB contamination at concentrations that are 50 ppm or greater in the columns and the miscellaneous spill areas (in the former areas of the transformers and motors and small oil stained areas in the basement) is assumed to be 1 inch or less. It is assumed that only the base of the columns in the process areas on the first and second floors is potentially contaminated. It is assumed that the oil-stained columns located below the process areas in the basement are most heavily contaminated toward the top of the column.

- The flooring material in the chip chute area is unknown at present, and may be comprised of concrete (unknown thickness) or soil. The depth of PCB contamination at concentrations that are at 50 ppm or greater is unknown.

Based on the criteria listed above, Table 3-1 presents the intervals in the selected areas of concern that will be sampled to define the vertical extent of PCB contamination:

3.1.4.2 Areas of Concern

Table 3-2 identifies the Areas of Concern that will be investigated. The limits of the Areas of Concerns were developed based on the information shown in Figures 1-2 and 1-3, and correspond to areas where PCBs were detected at concentrations greater than 5 ppm during the EBS. The locations of the Areas of Concern (proposed sampling locations) are shown on Figures 3-1, 3-2, and 3-3 for the basement, first floor, and second floor, respectively.

The flooring to be investigated on the first and second floor will be divided into 20 ft. by 20 ft. grid sectors based on the locations of building columns. Note that the limits of sampling the former process areas have be expanded to also include grid sectors located adjacent to the sectors designated as containing PCB contamination at concentrations above 5 ppm on Figures 1-2 and 1-3. In addition, it is assumed that there are 20 areas on the first and second floors containing miscellaneous PCB oil stains (located outside the process or traffic areas already designated for sampling) that will be investigated. It is also assumed that the miscellaneous oil-stained areas on the first and second floor will be investigated in the same fashion as the traffic or process areas on the first and second floor (i.e. contamination profiles are believed to be similar). Furthermore, it is assumed that there are 30 areas in the basement containing miscellaneous PCB oil stains that will be investigated. Miscellaneous oil-stained areas are assumed to be relatively limited in areal extent (i.e. 100 ft^2).

The sampling of the columns, Chip Chute waste pile, Chip Chute flooring, Chip Chute walls, former transformer locations in the basement, and miscellaneous oil stained areas in the basement will be conducted on a discrete basis. The areas of suspected PCB soil contamination located outside the building will be sampled based on a grid system.

3.1.4.3 Constraints on Data Collection

The sampling will be confined to areas where PCB contamination is suspected of being present at concentrations of 50 ppm or greater. This target concentration has been selected to support remediation of materials that will be disposed at a TSCA facility.

3.1.5 Develop a Decision Rule

Based on EPA guidance, the following decision rule has been adopted for this FSP:

> *If the mean contaminant concentration of total PCBs exceeds the action level (as defined in Section 3.1.6) in a selected area (sector) or at a discrete sample location, then the materials associated with that sector or location will be subject to disposal at a TSCA facility.*

The following criteria were used for purposes of defining sectors on concrete flooring:

- The concrete flooring on the first and second floors has been divided in 20 ft. by 20 ft. sector s defined at the corners by the existing columns.
- The area of concrete flooring beneath the former transformer and motor locations may be reduced or enlarged to include areas where visual oil staining is observed.
- The concrete flooring in the basement will be selected for sampling based on visual observation of oil staining.

The following criteria were used to define all other areas of concern:

- The area and volume of soil to be remediated that is located outside the building will be defined based on samples located in a sampling grid.
- Columns in the basement will be sampled at locations where visual oil staining is observed. Columns in the selected process areas will be sampled near the column base.
- The Chip Chute Area will be divided in five sectors; the northwest wall, the southeast wall, the northeast (back) wall, waste pile, and floor beneath the waste pile.

3.1.6 Evaluate Decision Errors and Optimize the Design

The PCB sampling data will be used to support a decision about whether an area will be remediated. Because of variability in contaminant concentrations within an area, practical constraints on sample sizes, and sampling or measurement error, the data collected may be inaccurate or non-representative and may mislead the decision makers into making an incorrect decision. A decision error occurs when sampling data mislead decision makers into choosing a course of action that is different from or less desirable than the course of action that would have been chosen with perfect information.

The EPA guidance, *Verification of PCB Spill Cleanup by Sampling and Analysis* (EPA, 1985), recognizes that data obtained from sampling and analysis are never perfectly representative and accurate, and that the costs of trying to achieve near-perfect results can outweigh the benefits.

Consequently, uncertainty in data must be tolerated to some degree. The DQO process controls the degree to which uncertainty in data affects the outcomes of decisions that are based on those data. This step of the DQO process allows the decision maker to set limits on the probabilities of making an incorrect decision.

The DQO process utilizes hypothesis tests to control decision errors. When performing a hypothesis test, a presumed or baseline condition, referred to as the "null hypothesis (H_0)", is established. This baseline condition is presumed to be true unless the data conclusively demonstrate otherwise, which is called "rejecting the null hypothesis" in favor of an alternative hypothesis.

When the hypothesis test is performed, two possible decision errors may occur:

1. Decide not to remediate an area (i.e., "walk away") when the correct decision (with complete and perfect information) would be to "remediate"
2. Decide to remediate when the correct decision would be to "walk away."

The first error would be a false negative, i.e., failure to detect the presence of PCB levels above the allowable limit. The second error would result in a false positive, i.e., concluding that PCBs are present at levels above the allowable limit when, in fact, they are not.

To minimize the likelihood of false negatives, the areas will be subdivided into sectors no larger than 400 ft^2. To protect against false positive findings due to analytical error, the measured PCB level in a single sample must exceed some value greater than 50 ppm for a finding of contamination. Assuming a 0.5% false positive rate and standard statistical techniques, the action level for a single sample would be:

$$(0.8)(50) + (2.576)(0.2)(0.8)(50) = 60\ ppm$$

where 0.8 (80%) represents the accuracy of the analytical method, 50 ppm is the allowable limit for a single sample, 2.576 is a coefficient from the standard normal distribution, and 0.2 (20%) is the standard deviation of the analytical method. Thus, if the measured level in a single sample is 60 ppm or greater, one can be 99.5% sure that the true level is 50 ppm or greater. However, in order to provide an even greater level certainty against false negatives, the action level will be set at 50 ppm.

To economize on the number of samples and analyses while providing areal coverage of the sampling area, the sectors of the concrete flooring will be subdivided into four quadrants. A sample aliquot will be collected at the center of each quadrant. The four aliquots will be composited and analyzed as one sample. If the sample result is 50 ppm or greater, then the sector will be designated for remediation. This concentration will represent an average of the four aliquots.

Letting X ppm be the measured concentration in the composite sample, then if $X \leq (50/4) = 12.5$ ppm, then individual samples are statistically predicted to be less than 50 ppm. If 12.5 ppm $< X <$ 50 ppm, no conclusion is possible based on the analysis of the composite and the four aliquots must be analyzed individually to reach a decision.

All other sample locations (the Chip Chute area, the columns, the soil located outside the building, and the miscellaneous oil-stained areas in the basement) will be selected on a discretionary basis to define the nature and extent of the PCB contamination.

3.2 Sample Collection Summary

Samples of the concrete flooring for PCBs will be collected using coring methods to the depths specified in Table 3-3. A core sample will be collected at each aliquot location. The sample collection procedure is discussed in Sections 4.3.1 and 4.3.2.

The materials comprising the waste pile in the Chip Chute area appear to be metal shavings and dirt/dust. Two grab samples will be collected of these materials and submitted for analysis of PCBs and TCLP. The grab samples will be collected at opposite ends of the pile with a bucket auger or shovel. The sample will be comprised of representative material from a sampling interval of 0 to 2 feet. The sample collection procedure for the waste pile is discussed in Section 4.3.4.

If present, the concrete beneath waste pile will be sampled by coring methods (refer to Section 4.3.2). The core samples will be collected at two locations (0-1 inch) corresponding to the locations where the waste pile samples will be collected. If a concrete floor is not present beneath the waste pile, then a sample of the soil beneath the waste pile will be collected at the same locations. Soil samples will also be collected from a grid area located outside the building, adjacent to the Chip Chute Area. Two intervals (0 to 6 inches and 12 to 18 inches) will be sampled at each location. Soil sampling procedures are discussed in Section 4.3.5.

The walls in the Chip Chute area will be sampled using drilling methods. Two samples will be collected from each of the three walls. A sample will be collected near the center of each half of the wall. The columns will also be sampled using drilling methods. The method of collection will be similar to the one used for collecting the samples of the Chip Chute walls. All wall and column samples will be collected from the depth interval 0-1-inch. The sample collection procedure for concrete walls and columns is discussed in Section 4.3.3.

4.0 Field Sampling Activities

This section presents a description of the field sampling and associated activities and protocols to be implemented during the sampling effort at Building 3. The activities discussed in this section include building surveying, sample layout, PCB sampling, waste characterization sampling, and equipment decontamination.

It should be noted that a project-specific Safety, Health and Emergency Response Plan (SHERP) for Building 3 field activities will be prepared separately. Personnel involved with the field activities described in this FSP shall comply with provisions in the SHERP. For reference, the anticipated personal protective equipment (PPE) required for field activities is indicated in the following discussions.

4.1 Building Contamination Survey

At the start of the field activities, field personnel will survey Building 3 for the presence of oil staining on columns or floors. The locations, dimensions, and description of the stained areas will be documented and sketched. The locations of the stained areas will then be marked for subsequent sampling. The building survey information will be used to identify biased locations for sampling of the floors and columns as described in Sections 4.3.2 and 4.3.3. Modified Level D PPE (including Nitrile gloves and foot covers) will be required for building survey activities.

4.2 Layout of Sampling Locations

Following the building survey, field personnel will identify all sampling locations (with the exception of the locations below the waste pile). Each location will be marked with the corresponding sample ID (refer to Section 5.3) using chalk or crayon. A member of the sampling team will review the locations to ensure that they do not conflict with building utilities. Additionally, sampling personnel will check the initial locations of samples outside the building relative to underground utilities. Underground utilities will be located using available building maps or by contacting Missouri One Call. If conflicts with utilities are identified, the sample location(s) will be moved to the nearest safe location. Field personnel will then ground-truth the locations of all samples by measuring from existing features (columns, walls, ceilings, doorways, etc.). The sample locations will be recorded on a base map of each floor of the building. Level D PPE (including Nitrile gloves and foot covers) will be required for layout activities.

4.3 PCB Sampling

Concrete, waste pile, or soil samples will be collected from the areas shown on Figures 3-1 and 3-2. These figures exclude the miscellaneous oil-stained areas and additional floor samples that may be collected based on the results of initial floor samples. All samples will be submitted to a USACE-approved laboratory as discussed in the QAPP. The overall sampling program involves the collection of five types of samples:

- Composite Concrete Samples – Floors (First and Second Floors)
- Discrete Concrete Samples – Floors (Basement, Transformer Vaults, Penthouse)
- Discrete Concrete Samples – Columns and Walls
- Grab Samples – Waste Pile
- Discrete Soil Samples

The total number of samples, analytical parameters, and analytical methods associated with each type of sample is given in Table 4-1 of the QAPP. The quantity and type of QA/QC samples associated with each type of sample is given in Table 6-1 of the QAPP. Sample containers, preservation procedures, holding times, and sample volumes associated with all of the sample types are given in Tables 5-1, 5-2, and 5-3 of the QAPP.

Due to the expected generation of a significant quantity of dust during field activities, Level C PPE (including half-face respirators with HEPA filters, Tyvek suits, Nitrile gloves, and foot covers) will be required for PCB sampling. In addition, steel-toed boots and protective leather gloves when operating concrete and drilling equipment.

4.3.1 Composite Concrete Samples – Floors

Composite samples will be collected from floors on the first and second floors of the building. The composite samples will be collected form two types of areas: former process areas and former traffic areas (refer to Figures 3-2 and 3-3 and Tables 4-1 and 4-2). As described in Section 5.3, a grid system will be established that subdivides the floors into sectors using building columns as reference points. In addition, composite samples will be collected from the discrete (biased) locations on the first and second floors based on the results of the building survey (i.e. miscellaneous oil-stained areas; refer to Section 4.1). [Note: Composite samples will not be collected from discretionary locations on the basement floor. Refer to Section 4.3.2 for a discussion of the collection of discrete samples from the basement floor.]

A single composite sample from each sector/location will be collected that consists of sample aliquots from four quadrants within the sector/location. The center point of each quadrant will

constitute the location of the aliquot. Composite concrete floor samples will be collected as follows:

- At the aliquot location, the concrete floor will be cored to the appropriate depth (2 below the interface of the concrete cap and original floor in the former traffic areas or 3 inches below the interface of the concrete cap and original floor in the former process areas) using a 1.5-inch inner diameter (ID) core sampler.

- The concrete core sample will then be saw-cut into individual sections corresponding to the sample depth interval (0–1 inches and 1-2 inches in the former traffic areas; 0-1 inches and 2-3 inches in the former process areas).

- The individual core section will then be drilled using a drill press or lathe equipped with a one-inch diameter drill bit. The powdered material (pulverized cuttings/particles) generated during the drilling operation will be collected in a bowl or other container positioned below the drill bit. The drill bit will be decontaminated between the core sections from different depth intervals (refer to Section 4.6).

- Precisely five (5) grams of the powdered material will be weighed on a laboratory-grade scale.

- The 5-gram sample will then be placed into the sample container designated for the specific location/sector and depth interval. The remaining powder and unused core section will be placed into a secondary container and labeled with the quadrant ID (refer to Section 5.3). This material will be retained for possible future analysis.

- The remaining aliquots from the same location/sector and depth interval will be prepared as described above. Precisely five (5) grams of powdered material from each of four (4) aliquots will be placed into the sample container.

- The sample, consisting of four (4) aliquots, will then be composited by aggressively shaking the material within the sample container. A sample container of adequate volume (4-ounce glass jar) will be used to ensure that there is sufficient space within the container for shaking and thoroughly mixing the material.

- After compositing, the sample container will be labeled with the sample ID for the specific location/sector and depth interval (refer to Section 5.3).

- The sampling equipment (core sampler, saw blade, drill bit, sample collection bowls, etc.) will be decontaminated between each sample location, aliquot, and depth interval to prevent cross-contamination of samples. Equipment decontamination procedures are described in Section 4.6.

4.3.2 Discrete Concrete Samples – Floors

Discrete concrete samples will be collected from floors in the basement, transformer vaults, and penthouse (former motor area) at the biased, oil-stained locations identified during the building survey (refer to Section 4.1). The samples will be collected using the same procedure described in Section 4.3.1 for composite floor samples; except, the sample will not consist of multiple aliquots. A single sample will be cored the appropriate depth and cut in sections corresponding to the sampling intervals similar to the former traffic areas. The individual sections will be drilled and the powdered material (drill cuttings) collected, weighed (30 grams), and placed into a sample container. The sample container will be labeled to identify the location and depth interval in accordance with Section 5.3.

4.3.3 Discrete Concrete Samples – Columns and Walls

Discrete samples will be collected from building columns on the first and second floors and in the basement. On the first and second floors, the columns to be sample include those located within areas designated for floor sampling. Columns to be sampled in the basement will be selected based on the results of the building survey.

Samples from columns on the first and second floors will collected at the base of each column. In the basement, samples will be collected from areas on the columns where significant oil staining was observed during the building survey, with preference towards the top of the columns. In the Chip Chute area, samples will be collected from each of the three walls. Two samples will be collected from each wall – one sample from the center of each half of the wall. Column and wall samples will be collected as follows:

- Using a drill with a one-inch bit, holes will be drilled in the vicinity of the sampling location to a depth of approximately 1 inch.
- The powdered material generated during the drilling process will be collected directly in the sample container designated for the specific location. This material will then and placed into the appropriate sample container.
- A sufficient number of holes will be drilled (to a depth of approximately one-inch) to produce the required sample mass (approximately 30 grams)
- After collection, the sample container will be labeled with the sample ID for the specific location (refer to Section 5.3).

- The sampling equipment (drill bit, etc.) will be decontaminated between each sample location to prevent cross-contamination of samples. Equipment decontamination procedures are described in Section 4.6.

4.3.4 Grab Samples – Waste Pile

Two grab samples, taken from opposite sides of the Chip Chute waste pile, will be collected as follows:

- Samples will be collected using a bucket auger or shovel. Samples will be advanced to a depth of approximately 2 feet.
- Waste material from the 0 – 2 feet interval will be thoroughly mixed in a stainless steel bowl with a stainless steel spoon.
- After mixing, a sufficient quantity (enough to fill each sample container) of waste material will be placed in the sample container designated for the specific location. The container will be labeled with the sample ID corresponding to the location (refer to Section 5.3).
- Extra material will be returned to the waste pile. The waste pile will eventually be removed and disposed, pending waste characterization analysis.
- The sampling equipment (shovel, mixing bowl, etc.) will be decontaminated between the two sampling locations as described in Section 4.6.

4.3.5 Discrete Soil Samples

Soil samples will be collected at twelve (12) sample locations within an area outside Building 3 adjacent to the Chip Chute. These samples will be distributed on a 15-foot grid spacing within an area of concern with dimensions of 30 feet by 45 feet. Soil samples will also be collected below the Chip Chute waste pile. If concrete flooring is present below the waste pile, soil samples will be collected via the holes created from concrete coring. If concrete is not present below the waste pile, samples will be collected from the soil approximately below the location of prior waste pile samples (refer to Section 4.3.4). Soil samples will be collected as follows:

- Discrete soil samples will be collected using a stainless steel hand auger and/or a small barrel drive sampler. The auger or driver will be advanced to the appropriate depth interval (0 – 6 in. and 12 – 18 in.).
- Soil from each depth interval will be thoroughly mixed in a stainless steel bowl with a stainless steel spoon.

- After mixing, a sufficient quantity of soil (enough to fill the sample container) will be placed in a sample container designated for the specific location and depth interval. The container will be labeled with the sample ID corresponding to the location and depth interval (refer to Section 5.3).

- Extra soil from the sample boring will be returned to the borehole.

- The sampling equipment (auger, mixing bowl, etc.) will decontaminated between each sampling location and between each depth interval as described in Section 4.6.

4.4 Remediation Waste Characterization Sampling

Based on the results of PCB sampling, areas of Building 3 containing PCBs at concentrations at or exceeding the action level will subsequently be remediated. The remediation will involve the removal and disposal of select portions of Building 3, the Chip Chute waste pile (in its entirety), and possibly soil beneath/adjacent to the Chip Chute. To select the appropriate disposal facility and/or to meet the waste disposal acceptance criteria of the disposal facility, the chemical composition of the remediation-derived waste materials (concrete, waste pile, soil) must be determined. Waste materials must be properly classified in accordance with RCRA and TSCA (i.e. hazardous waste, special waste, TSCA waste, non-hazardous waste). The collection and analysis of PCB characterization samples, as discussed in Section 4.3, will be sufficient for assessing disposal options related to TSCA. However, additional samples will need be collected and analyzed to satisfy RCRA requirements. During the investigation, representative samples of concrete, soil, and waste pile material will be collected and submitted to a USACE-approved laboratory for analysis of semi-volatile organic compounds (SVOCs) and metals per the Toxicity Characteristic Leaching Procedure (TCLP) (refer to QAPP). Table 3-4 summarizes the sampling approach and estimated quantities for remediation waste characterization samples. Sampling will be performed in Level C PPE as specified for PCB sampling, unless the samples are prepared at a location not impacted by PCB sampling activities.

4.5 Health and Safety Characterization Sampling

The remediation of Building 3 will likely generate significant quantities of dust and debris. During remediation activities, workers could potentially be exposed to these materials and associated contaminants. Therefore, as part of this investigation, additional samples will be collected and analyzed to characterize the contaminants that may be present in dust and debris. Contaminant concentrations will be compared to OSHA permissible exposure limits. The collection and analysis of PCB characterization samples, as discussed in Section 4.3, will be

sufficient for assessing the health and safety concerns associated with exposure to PCBs. However, samples will need to be collected to assess other contaminants that could present a health and safety concern.

It is assumed that exposure to site soils and waste pile materials will be minimal, and that these materials are not likely to become airborne during removal. Thus, health and safety characterization sampling will focus on Building 3 concrete. Potentially hazardous constituents associated with concrete include SVOCs and metals. During the investigation, five random samples of concrete will be collected and analyzed for Total SVOCs and Total Metals. Samples will be collected from the excess concrete powder remaining from PCB floor sampling. Concrete powder from any of the locations/quadrants and depth intervals may be combined to provide sufficient volume for the samples. Sampling will be performed in Level C PPE as specified for PCB sampling, unless the samples are prepared at a location not impacted by PCB sampling activities.

4.6 Equipment Decontamination

Field personnel will exercise caution in decontaminating coring equipment, drill press, concrete saw, mixing bowls, mixing spoons, and hand tools. Sampling equipment will be decontaminated between each sample location, aliquot, and depth interval (soil samples). The decontamination procedure will include a wash with Alconox soap and water followed by a rinse with the analytical grade methanol and then with deionized/distilled water. All decontamination fluids will be containerized and managed as investigation-derived waste (IDW) as discussed in Section 7.0. At the conclusion of the project, samples of decontamination water will be collected and analyzed to assess the disposal options. The sampling of IDW is also discussed in Section 7.0. Level C PPE, as specified for sampling activities, will also be required equipment decontamination.

5.0 Sample Chain-of-Custody and Documentation

During field sampling activities, traceability of the samples must be maintained from the time the samples are collected until laboratory data are issued and samples appropriately disposed. Initial information concerning collection of the samples will be recorded in a field logbook. Information regarding the transfer, handling, and shipping of all samples will be recorded on a Chain-of-Custody (COC) included in Appendix A.

The sampler will be responsible for initiating and filling out the COC. The field team members are responsible for the care and custody of the samples collected until the samples are transferred to another individual or shipped to the analytical laboratory. The field team, under the direction of the Field Supervisor, is responsible for enforcing COC procedures during fieldwork. The COC will be signed, with date and time, by the sampler when samples are relinquished to anyone else. The COC will accompany the samples at all times. All individuals who subsequently take possession of the samples will also sign, with date and time, the COC.

Each cooler containing samples sent to the analytical laboratory will be accompanied by the COC. Laboratory personnel are responsible for the receipt and entry of samples into the laboratory which have been submitted under a COC document. Additionally, samples received will be entered into the laboratory COC system by properly documenting and maintaining COC from the moment that they take custody of the sample until the sample is properly disposed.

5.1 Field Logbook

Field logbooks will be maintained to record all pertinent information. Entries will be as descriptive and detailed as possible so that a particular situation can be reconstructed without reliance on the collector's memory. Field logbooks (which will consist of a 5 x 7 1/2-inch bound book with consecutively numbered pages) will be kept by a field representative.

The cover of each field logbook will contain the following information:

- Project name and number
- Book number
- Activity type
- Start date
- Stop date.

Entries to a field logbook will be made daily and, at a minimum, will consist of the following:

- Date
- Start time
- Weather
- All field personnel present
- Visitors to the site (time, name, and company)
- Level of personnel protection used
- Type of activity conducted
- Sampling location
- Sample identification number
- Description of sampling point
- Method of sampling
- Type of sample
- Air monitoring readings, if applicable
- Pertinent field observations
- Field measurements, if applicable
- Anticipated disposition of sample
- Description of all related activities
- Signature of the person making the entry.

All measurements made and samples collected will be recorded. All entries will be made in indelible ink. No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark and initialed. Entries will be organized into easily understandable tables, if possible.

At each location where a sample is collected or a measurement made, a detailed entry of the sampling location, equipment used to collect the sample(s), depth interval, time of sample collection, number of samples, types of analysis, and number and types of sample containers will be recorded. All equipment used to make measurements, if necessary, will be identified, including the date on which the equipment was calibrated.

Field documentation requirements associated with site health and safety will be presented in the SHERP.

5.2 Photographs

Color digital photographs will be taken prior to, during, and after conducting field activities. Photographs will be tracked with a numbered photograph log that will include the project name,

date, and description of activity or location (e.g., oil stained area, waste pile, core sampling, and soil sampling).

5.3 Sample Numbering System

The sample numbering system will provide a tracking number to allow retrieval of the sample and exact identification of the sample location. Each type of sample collected will be identified by a two-letter prefix code as follows:

- CF – Concrete Floor Sample
- CW – Concrete Wall Sample
- CC – Concrete Column Sample
- SS - Soil Sample
- WP- Waste Pile Sample
- IW – Investigation Waste Sample

An alphanumeric designation will follow the sample type prefix to identify the sample location of sample collected on the first and second floor. The alphanumeric designation will correspond to the column identification (i.e. "C11" would correspond to the column located in row C, column 11; refer to Figures 1-2 and 1-3) located in the northern most corner of the sector sampled. The sample of the columns on the first and second floor will be identified by the column location (i.e "C11" would correspond to the column located in row C, column 11; refer to Figures 1-2 and 1-3). For example, CF-D12 indicates a concrete floor sample from the sector located adjacent to column D12.

The aliquots from each sector will be designated with the letter A, B, C, or D depending on which quadrant it was collected in. For example, CF-G14A indicates a concrete floor sample from quadrant "A" of the sector located adjacent to column G14. Quadrant "A" will represent the quadrant located adjacent to the referenced column. The remaining quadrants (B, C, and D) will be designated in counter clockwise fashion from quadrant "A".

Where applicable, the sample identification number will include a two-digit number following the sample type and location prefixes to identify the sampling interval. For example, CF-D12-23 indicates a concrete floor sample from the sector located adjacent to column D12 at a sampling interval of 2 to 3 inches below the original floor surface.

For field duplicates, the sample identification number will have a "500" added to make it unrecognizable to the subcontract laboratory. For example, sample identification CF-D12-23 would be CF-D512-23 if it is a field duplicate. For sample splits to the USACE quality assurance laboratory, the sample identification will have a "D" added as a suffix. For example, CF-D12-23 would be CF-D12-23D if it is a split sample.

For rinsates, the sample identification number will have a "R" added as a suffix to the sample identification number of the sample collected prior to the rinsate. For example, CF-D12-23R would be a rinsate collected immediately after the concrete floor sample CF-D12-23.

5.4 Sample Documentation

Sample documentation will be conducted in accordance with the following subsections.

5.4.1 Sample Labels

Each sample collected for chemical analysis, or archived for possible future analysis, will be placed in the appropriate container(s) and labeled at the time of sample collection with the following information:

- Arrowhead project number and name
- Sample number
- Date and time of collection
- Required analyses and methods
- Matrix sampled
- Type of preservative, if applicable
- Volume of sample and container type
- The name of the sampler
- Initials of the sampler and date.

5.4.2 Sample Collection Field Sheets

An example of a Field Sample Collection Sheet to be used to document pertinent information associated with the various samples is presented Appendix A.

5.4.3 Chain of Custody Procedure

The COC procedures are as follows:

- At the time of sample collection, the COC is completed for the sample collected.

- The field team members will cross-check the form for possible errors. Corrections will be made to the record with a single strike mark and dated and initialed. All entries will be made in blue or black ink. The COC will be signed when the samples are relinquished.

- A shipping bill will be completed and the shipping bill number recorded on the COC prior to enclosing inside a clear plastic bag and attaching it to the inside of the cooler lid.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing, with date and time, the COC. The field sample coordinator will group samples for shipment to the analytical laboratory and complete a COC for each cooler of samples. Samples will be packaged for shipment and dispatched to the analytical laboratory with a separate COC accompanying each cooler.

Custody seals will be used to ensure that sample shipping containers have not been opened during shipment and prior to receipt at the off-site laboratory. The following information will be included on the custody seals:

- Signature of the sample coordinator
- Date when the sample package is sealed.

All seals will be completed using indelible ink. The seals will be affixed to the front and back of the cooler, at the interface of the cooler and the lid. The placement of the seals will be in a manner that breaking the seals would be necessary in order to open the sample shipping cooler.

In conjunction with data reporting, the analytical laboratory will return the original or a photocopy of the original COC to the Contractor for inclusion into the project file.

All samples collected will remain in the possession of the sampling crew until shipment. Locked vehicles or trailers will be used for interim storage if necessary. If coolers (used for sample storage) must be left unattended for extended periods of time, signed custody seals will be placed on the front and back of each cooler or the cooler will be stored under lock until shipped to the off-site laboratory.

When the analytical laboratory receives the sample coolers, a receipt for sample for will be initialed. The laboratory will document the sample condition upon receipt. All receipt nonconformance situations will be reported immediately to the Field Supervisor.

5.4.5 COC Documentation

A copy of each COC will be retained by the sampling team for the project file and the original sent with the samples. For sample packages sent by carrier to a laboratory off-site, bills of lading will be retained as part of the documentation for the COC records.

6.0 Sample Packaging and Shipping

This section describes packaging and shipping procedures for collecting environmental samples. Samples will be shipped off-site according to applicable guidance documents and U.S. Department of Transportation (DOT) regulations. To minimize sample container breakage and provide adequate sample temperature during shipment, sample containers will be prepared and packaged according to the following procedures:

- Secure sample bottle lids. Ensure that the sample label is securely attached by placing clear tape over the label.
- Place custody tape over the sample container lid or cap.
- Place sample bottles in Styrofoam sleeves (if provided); or place sample bottles in reclosable clear plastic bags and wrap them with protective packing material.
- Tape the drain hole shut on the inside and outside of a waterproof metal (or equivalent strength plastic) cooler.
- Line the sides and floor of the cooler with protective packing material.
- Line the cooler with a large plastic bag.
- Place containers upright in the cooler in such a way that they do not touch.
- Packing material will be placed in appropriate locations to minimize potential container breakage during shipment. Care will be taken so that the packing material does not thermally insulate the containers from the ice placed in the shipping container.
- Pack the area surrounding the samples with ice (either chemical ice packs or ice cubes sealed in plastic bags).
- Fill the remaining space in the cooler with cushioning material.
- Close the large plastic bag in the cooler and tape or secure shut.
- Place the completed COC and other paperwork in a sealed, clear plastic bag and tape the bag to the inside lid of the cooler. (Note: The original COC will accompany the shipment, and copies will be retained by the sampler for return to project management and the project file).

- Wrap the cooler completely around with strapping tape at two locations. Do not cover any labels.
- Place the address label of the shipment destination on top of cooler.
- Affix signed custody seals on the cooler at the interface between the cooler and the lid, both in the front and back sides. Cover the seals with wide, clear tape.
- Make a copy of the shipping air bill for the project file and place the original in a clear envelope secured to the outside of the cooler lid.

Samples will be sent to an off-site laboratory by use of an overnight courier delivery service. Prior to shipment of samples, arrangements will be made with the laboratory to receive and analyze the samples.

Laboratory specific receiving and handling procedures will be described in the Laboratory Quality Assurance Plans.

Key personnel contacts are provided below:

ANALYTICAL LABORATORY
TBD

CENWK
U.S. Army Corps of Engineers
ATTN: CENWK-PM-ED (Dan Mroz)
Technical Manager
700 Federal Building, 6th Floor
601 E. 12th Street
Kansas City, MO 64106
(816) 983-3368

U.S. Army Corps of Engineers
ATTN: CENWK-EP-ED (Kurt Baer)
Project Engineer
700 Federal Building, 6th Floor
601 E. 12th Street
Kansas City, MO 64106
(816) 983-3392

U.S. Army Corps of Engineers
ATTN: CENWK-EC-DC (Francis Zigmund)
Project Chemist
700 Federal Building, 6th Floor
601 E. 12th Street
Kansas City, MO 64106
(816) 983-3905

CQAB
Ms. Laura Percifield
420 South 18th Street
Omaha, NE 68102

(402) 444-4314

ARROWHEAD

Greg Wallace, Project Manager
12920 Metcalf, Suite 150
Overland Park, Kansas 66213
(913) 814-9994

Scott Siegwald, Project Manager
12920 Metcalf, Suite 150
Overland Park, Kansas 66213
(913) 814-9994

7.0 Investigation-Derived Waste Management

IDW generated during project activities will include decontamination (rinse) water, soil from soil borings, concrete from concrete sampling, and PPE. General procedures for managing IDW are as follows:

- Decontamination fluids and fluids generated during sampling activities will be containerized in a holding tank or in 55-gallon drums. Containerized decontamination fluids will be labeled and inventoried. Labels shall, at a minimum, define the contents, the date the IDW was collected, and the reason for containerization. An up-to-date container inventory will be maintained on site that documents the type of container, the contents of the container, date of arrival at storage area, and the container status (e.g., awaiting analytical results). In addition, routine visual inspections of the storage area will be made to identify areas of potential leaks or spills. At the conclusion of the field sampling activities, samples of the containerized fluids will be submitted to the analytical laboratory for analysis of PCBs, Total SVOCs, and Total Metals as discussed below.

- Unused portions of soil samples will be returned to the sampling location (i.e. placed back into the bore hole).

- Unused portions of concrete from concrete samples and miscellaneous concrete cuttings will be containerized in 55-gallon drums. This material will be disposed during remediation of Building 3 in a manner consistent with remediation waste materials. This determination will be based on waste characterization sampling as described in Section 4.4.

- Personnel protective clothing will be placed in plastic trash bags and disposed as municipal waste.

Waste handling, storage treatment and final disposition will be planned before an activity handles or generates waste. Waste minimization will involve the following objectives:

- Remove as little waste as possible from trenches or boreholes

- Segregate clean fill from contaminated soil and water

- Plan for incorporating waste into anticipated final remedies for the operable unit, when possible

- Minimize volume by cleaning, compacting, drying, and decanting

- Separate soil waste media from water waste
- Plan not to mix contaminant in containers; segregate wastes by contaminants
- Clean contaminated PPE if possible and dispose as solid municipal waste if necessary
- Use waste minimization as a design criteria and for planning for design life cycles, per U.S. Department of Defense (DoD) directives
- When possible, budget final waste disposal costs within each activity budget and each activity schedule to avoid accumulating waste.

Decontamination fluids will be sampled via an access port at the top of the drum or holding tank using a decontaminated bottle sampler. The sample will be transferred to the appropriate sample containers (refer to Section 5.0 of the QAPP). A Water Sample Collection Field Sheet (refer to Appendix A) will be completed and the following information recorded in a field logbook:

- Date/time of sampling
- Sampling team personnel
- Sample number
- Quantity of decontamination fluid in container
- Location of container sampled
- Other data as required.

Samples of decontamination fluids will be packaged and shipped to the designated analytical laboratory as discussed in Section 6.0 this FSP.

8.0 Contractor Quality Control

This section provides the criteria for the performance of inspections of each Derfinable Feature of Work (DFW) associated with the field activities. Inspections are the processes whereby the Quality Control (QC) Inspector, by examination or measurement, determines that an activity complies with the specified quality requirements. The inspection system is based on the USACE three-phase system of control to cover the activities. The three-phase inspection system consists of preparatory, initial, and follow-up inspections for applicable DFWs.

8.1 Definable Features of Work

A DFW is defined as a major work element that must be performed in order to execute and complete the project. It consists of an activity or task that is separate and distinct from other activities and requires separate control activities. The following DFWs have been identified for the planned field activites:

- Layout and Building Survey
- Concrete Floor Sampling
- Concrete Wall and Column Sampling
- Waste Pile Sampling
- Soil Sampling
- Investigation Derived Waste Sampling

A detailed inspection checklists for each of these DFWs is included in Appendix A.

8.2 QC Inspections

The QC Inspector will coordinate inspection activities with the Project Manager, subcontractors, and field personnel. Inspection activities will be performed on a periodic basis.

8.2.1 Preparatory Inspections

Preparatory inspections will be performed prior to the initiation of all DFWs. The preparatory inspection is performed in advance of any work being performed to enable all involved parties to determine whether or not everything is properly in place and ready to initiate the work activity. This inspection will be conducted by the QC Inspector and will be attended by field personnel and subcontractors. The preparatory inspection will be scheduled prior to the start of the DFW. All affected parties will be notified in advance of the inspection to coordinate their participation. The preparatory inspection will include, but is not limited to:

- Review of pertinent contract requirements, specifications, and plans
- Review of required control inspections and test requirements
- Review of reports, forms, and checklists that need to be filled out during the activity
- Review of subcontracts and purchase orders
- Review of required licenses, permits, and utility notifications
- Establish that required planning documents have been reviewed and approved by USACE and regulators
- Establish that the required materials and equipment for commencement of the DFW are on-hand or available and are in accordance with specifications, plans, and calibration requirements
- Establish that the preliminary work required to begin the DFW is complete and conforms to approved plans, drawings, and specifications
- Schedule the date that the initial inspection, if required, will be performed
- Review, discuss, and approve any applicable Activity Hazard Analysis(es) for the DFW.

For analytical activities, the QC Inspector will contact the laboratory to insure they are ready to begin accepting samples and to review any questions regarding the requirements of the QAPP or the subcontract.

8.2.2 Initial Inspections

Initial inspections will be conducted at the initiation of a DFW. The initial inspection will provide the opportunity for the QC Inspector to observe the actual initiation of the work activity and the individual segments of the DFW. The inspection will be performed on a representative sample of work to evaluate the following criteria:

- Compliance with the plans, specifications, drawings, approved submittals, and other contract requirements
- Acceptable levels of workmanship

- Identify use of defective or damaged materials
- Identify improper procedures or methods
- Acceptable test or inspection results
- Compliance with the Safety, Health, and Emergency Response Plan (SHERP).

8.2.3 Daily QC Inspections

Daily QC inspections of field activities will be performed on a daily basis when work on a DFW is in progress. The Daily QC inspections will be performed until all work on a DFW is completed. The following items will be performed during the Daily QC inspection:

- Verify compliance with the plans, specifications, drawings, approved submittals, and other contract requirements
- Verify level of workmanship, if applicable
- Verify test or inspection results
- Verify nonconformances are identified, corrected, and re-inspected
- Verify compliance with the SHERP.

8.2.4 Documentation

The preparatory, initial, and follow-up inspections will be documented on forms. Example Preparatory, Initial and Daily QC Inspection Checklist are provided in Appendix A. The Daily QC Inspection Checklist will be attached to the Daily Quality Control Report (DQCR) (refer to Section 8.3) and submitted to the USACE on a weekly basis during performance of the activity. If a final inspection for either a specific task or the entire project is required, this information will be provided on the Final Inspection Form presented Appendix A.

If the inspection process identifies a nonconforming condition, it will be documented, tracked, and corrected. Non-conformance Reports (NCR) and Corrective Action Requests (CARs) will also be attached to the Daily Quality Control Report (refer to Section 9.0).

8.3 Daily Quality Control Reports

DQCRs will be prepared to document field activities performed. Quality control personnel will prepare DQCRs with input from the Field Supervisor, sampling personnel, and others conducting

the field activities. The DQCRs will contain the following information pertaining to the field sampling activities:

- Weather information at the time of sampling
- Sample collection field sheets
- Copies of field logbooks
- Copies of COC forms
- Field instrument calibration forms
- Field instrument measurements
- Verbal instructions received from CENWK or AMCOM personnel
- Problems encountered during sampling
- Field Work Variances
- Forms included in this SAPs.

Attachments to the DQCR will include:

- Daily QC Inspection Checklist
- CAR, if necessary
- NCR, if necessary
- Daily Chemical Data Report (refer to Section 15.0 of the QAPP)

9.0 Field Corrective Actions

Corrective actions will be implemented by the Contractor or its subcontractors to correct nonconformances identified during QC inspections or during the course of conducting activities. A nonconformance is defined as a deficiency in implementation of a procedure or standard that renders the quality of an item or activity unacceptable or indeterminate with respect to the acceptability criteria. Correction of nonconformances will be focused at determining the cause of the deficiency and instituting actions to correct the deficiency and prevent recurrence.

Corrective actions will be implemented and documented via a CAR. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are deemed insufficient, work may be stopped through a stop-work order issued by the Contractor Project Manager and/or the CENWK Project Manager

9.1 Nonconformance Reporting

Noncompliance with specified criteria will be documented through a formal nonconformance control and corrective action program. Personnel who identify a nonconformance are responsible for notifying the Contractor Project Manger of the nonconformance. The Contractor Project Manager will discuss the nonconformance with USACE on-site representative to determine if the nonconformance has been properly described and that applicable project requirements or criteria have not been met to warrant issuance of a NCR (refer to Appendix A). The Contractor Project Manager will immediately notify the CENWK PM of any major or critical deficiencies (i.e., deficiencies requiring re-sampling, re-analysis of samples, or re-drilling/coring) identified during the course of project execution.

9.2 Nonconformance Disposition and Tracking

Corrective actions required to bring nonconforming conditions into compliance will be approved by the Contractor Project Manager prior to implementation. Corrective actions will be documented in a field CAR, which will be attached to DQCR. NCRs will remain on open status and tracked until the corrective actions have been implemented and verified acceptable by the Contractor Project Manager. If appropriate, the Contractor Project Manager will ensure that no additional work associated with the nonconforming activity is performed until the corrective actions are completed. This will be implemented through a stop-work order issued by the Contractor Project Manager.

9.3 Field Work Variances

Changes to approved plans or procedures may be required when events occur or presumed information must be altered based on actual conditions encountered during the course of field activities. Request for approval to vary from approved plans, specifications or procedures will be submitted to the CENWK with a Field Work Variance (FWV) (refer to Appendix A). Minor variances can be implemented in the field prior to receipt of written approval of the FWV when approved by the USACE on-site representative. Minor variances are defined as those variances that do not affect project cost, schedule, quality or quantities. Major variances require written approval prior to implementation. Major variances impact cost, schedule, quality, and quantities and vary from the approved plans, specifications, or procedures. FWVs will be submitted to the USACE COR for approval. All changes as a result of FWVs will be documented on the as-built drawings, field documentation and project documents.

10.0 Project Schedule

The procurement of Subcontractors, equipment, and supplies will begin approximately 4 weeks prior to fieldwork. Fieldwork is tentatively scheduled to begin in the middle to late June 2001. The estimated time to completion for fieldwork is 6 weeks. The final results of chemical analysis will be completed approximately 3 weeks after the field is completed. It is anticipated that the results of this investigation will be summarized in a Data Report. A draft version of the Data Report will be completed approximately one month after the all the chemical analysis results are received.

11.0 References

United States Environmental Protection Agency (EPA). 1996. Soil Screening Guidance: Technical Background Document. May.

United States Aviation and Missile Command (AMCOM). 2000. Final Environmental Baseline Survey Report, Saint Louis Army Ammunition Plant, St. Louis, Missouri. December.

United States Aviation and Missile Command (AMCOM). 2001. Alternatives Evaluation for Removal of PCBs, Saint Louis Army Ammunition Plant, St. Louis, Missouri. December.

Tables

Table 1-1

Summary of Physical Features of Building 3

Building Characteristics	
Area	Basement: 37,000 square feet (ft^2) First Floor: 168,000 ft^2 Second Floor: 154,780 ft^2 Penthouse: 6,813 ft^2
Style	Two stories, basement, and two penthouses
Construction Materials	Steel frame and roof beams on reinforced concrete piers and spread footings; masonry walls; and a prefabricated concrete roof. The eastside addition has the same structure, but also is covered with asbestos siding.
Construction Date	Built in 1941, retooled (including eastside addition) in 1944. Renovated to create office space in 1984 and 1985.

Historical Use	
Occupants/Lessees	1941 to 1944: SLOP (0.30-caliber munitions production) 1944 to 1984: SLAAP (105-millimeter (mm) Howitzer shell production – intermittent production) 1985 to 1996: SLAAP (AVSCOM office space)
Operational Periods	1941 to 1944: 0.30-caliber munitions production 1944 to 1945: 105-mm Howitzer shell production 1952 to 1954: 105-mm Howitzer shell production 1966 to 1969: 105-mm Howitzer shell production 1985 to 1996: Office space
Historical Processes	
Process Description	Processes completed in Building 3 consisted of shell shaping, heat tracing, cleaning, painting, and packaging for shipment. Metal chips and fragments produced as a result of the shell machining processes were collected on the first and second floors and disposed in the chip chute. The chip chute is an open chute along the north wall that opened to the basement in Building 3. From the basement, the metal chips were transferred to a railcar via conveyor for off-site disposal.
Process Machinery	Process machinery included lathes, drill presses, milling machines, grinders, heat-treating furnaces, wash racks, welders, shapers, shot-blasting equipment, paint spray booths, transformers, air compressors, and auxiliary equipment (dust collection devices, elevators, and conveyors).
Process Utilities	Process utilities included water, steam, compressed air, soluble oil, quench oil, paint, natural gas, telephone service, and electricity.
Hazardous Material Information	
Possible Hazardous Material Used	Cutting (soluble) oil*, quench oil (No. 6 fuel oil), hydraulic oil, solvents (toluene), asbestos, lead-based paint, and pesticides.

* contained polychlorinated biphenyls (PCBs)

Table 2-1

Summary of Project Organization and Responsibilities

KEY PERSONNEL	ORGANIZATION	ROLE	RESPONSIBILITIES
Sandy Olinger	AMCOM	Project Manager	• Contract management
Dan Mroz	CENWK	Project Manager	• Technical oversight • Right of entries • Request LIMS number from CQAB
Laura Percifield	CQAB	Laboratory Supervisor	• QA sample analysis • Assign LIMS number for off-site analysis
Greg Wallace, R.G.	Arrowhead	Project Manager	• Primary contact point with CENWK and AMCOM • Overall responsibility for all phases of work
Scott Siegwald	Arrowhead	Field Supervisor	• Oversight of filed activities • Technical direction to field subcontractors and field personnel • Directing overall chemical QA\QC program • Oversight of Off-Site Chemical Laboratory • Coordination with CQAB • Preparation of report
Doug Ronk	Arrowhead	Sampling Team Leader	• Oversight of sample collection • Layout of sample locations • Preparation of Daily Quality Control Reports
Ben Williams Andy Arnold TBD TBD	Arrowhead	Sampling Team	• Assist with sample collection • Preparation of sample for off-site analysis • Decontamination
TBD	TBD	Health & Safety Officer and QC Inspector	• On-site H&S Oversight • QC Inspections
TBD	TBD		• Concrete coring services
Diane Borthwick		Data Management	• Download of laboratory and field electronic data files into database • Coordination with personnel involved with data validation, QCSR, and report preparation
Francis Zigmund	CENWK	Project Chemist	• Chemistry oversight
Kurt Baer	CENWK	Project Engineer	• Technical oversight

KEY PERSONNEL	ORGANIZATION	ROLE	RESPONSIBILITIES
	CENWK	Health & Safety	• Health & Safety
TBD	TBD	Analytical laboratory for off-site analysis of PCBs and other parameters.	• Chemical analysis • Laboratory QA/QC • Raw data summary report

Note: Any changes in personnel assignments are subject to CENWK approval.

Table 3-1

Summary of Sampling Depth Intervals by Selected Area

Media	Area of Concern	Sampling Intervals
Concrete	Flooring –1st Floor Former Process Areas	0 to 1 inch below concrete cap, and 2 to 3 inches below concrete cap
Concrete	Flooring –1st Floor Former Traffic Areas	0 to 1 inch below concrete cap, and 1 to 2 inches below concrete cap
Concrete	Flooring – 2nd Floor Former Process Areas	0 to 1 inch below concrete cap, and 2 to 3 inches below concrete cap
Concrete	Flooring –2nd Floor Former Traffic Areas	0 to 1 inch below concrete cap, and 1 to 2 inches below concrete cap
Concrete	Columns in Process Areas and Basement	0 to 1 inch
Concrete	Former Areas of Transformers and Motors	0 to 1 inch below concrete cap, if present, and 1 to 2 inches below concrete cap, if present
Concrete	Miscellaneous oil-stained areas on the first and second floors	0 to 1 inch below concrete cap, if present, and 1 to 2 inches below concrete cap, if present
Concrete	Miscellaneous oil-stained areas in the basement	0 to 1 inch and 1 to 2 inches
Waste Pile	Chip Chute Area	0 to 2 feet
Concrete	Walls in Chip Chute Area	0 to 1 inch
Concrete (if present)	Flooring below waste pile in Chip Chute Area	0 to 1 inch
Soil	Soil below flooring or directly below waste pile in Chip Chute Area	0 to 6 inches and 12 to 18 inches
Soil	Area outside Building and Adjacent to Chip Chute Area	0 to 6 inches and 12 to 18 inches

Table 3-2

Summary of Areas of Concern and Estimated Number of Samples

Media	Area of Concern	Number of 20' X 20' Sections, if Applicable	Estimated Number of Sample Locations	Estimated Number of Samples	Estimated Area to be Investigated or Number of Columns
Concrete	Flooring –1st Floor Former Process Areas	115	115	230	46,000 ft^2
Concrete	Flooring –1st Floor Former Traffic Areas	92	92	184	36,800 ft^2
Concrete	Flooring – 2nd Floor Former Process Areas	48	48	96	19200 ft^2
Concrete	Flooring –2nd Floor Former Traffic Areas	21	21	42	8,400 ft^2
Concrete	Columns	NA	163	163	163
Concrete	Former Areas of Transformers in the Basement	4	4	8	400 ft^2
Concrete	Former Areas of Motors in the Penthouse	4	4	8	3,200 ft^2
Concrete	Miscellaneous oil stained areas on first and second floor	NA	20	40	2,000 ft^2
Concrete	Miscellaneous oil stained areas in basement	NA	30	60	3,000 ft^2
Waste Pile	Chip Chute Area	NA	2	2	1,200 ft^2
Concrete	Walls in the Chip Chute Area	NA	6	6	1,100 ft^2
Concrete (if present)	Flooring below Waste Pile in Chip Chute Area	NA	2	2	1,200 ft^2
Soil	Soil Below Flooring or directly below Waste Pile in Chip Chute Area	NA	2	4	1,200 ft^2
Soil	Area outside Building and Adjacent to Chip Chute Area	NA	12	24	1,350 ft^2

Table 3-3

Estimated Sampling Depths for Concrete Flooring by Selected Area

Media	Area of Concern	Sampling Depth[1]
Concrete	Flooring –1st Floor Former Process Areas	7 inches
Concrete	Flooring –1st Floor Former Traffic Areas	6 inches
Concrete	Flooring – 2nd Floor Former Process Areas	7 inches
Concrete	Flooring –2nd Floor Former Traffic Areas	6 inches
Concrete	Former Areas of Transformers and Motors and in the Miscellaneous Oil Stained Areas	6 inches
Concrete	Miscellaneous Oil Stained Areas in Traffic Areas	6 inches
Concrete	Miscellaneous Oil Stained Areas in Process Areas	7 inches
Concrete	Miscellaneous Oil Stained Areas in Basement	6 inches

[1] The specified depth assumes that the cap thickness is 4 inches

Table 3-4

Remediation Waste Characterization Sampling Approach and Sample Quantities

Material Type	Sampling Approach	Estimated Sample Quantity
Concrete	Seven samples of concrete floor material will be collected for waste characterization – 3 each from the first floor and second floor and one from the basement. Samples will be collected from the excess concrete powder from PCB floor sampling (refer to Section 4.3). Excess concrete powder from any of the locations/quadrants (on the same floor) may be combined to provide sufficient volume for each waste characterization sample. Samples will be taken from the 0 – 1 in. interval.	7
Waste Pile	One grab sample will be collected from Chip Chute waste pile.	1
Soil	One sample will be collected from soil below the Chip Chute waste pile and one sample from the soil outside Building 3 (adjacent to the Chip Chute area). Samples may be collected from the same borings as the corresponding PCB characterization samples, assuming sufficient sample volume. Otherwise, an additional location in the general area of the corresponding PCB samples will be sampled. Each sample will be a composite of soil from the 0 – 6 in. and 12 – 18 in. depth interval.	2

Note: The samples described above will be analyzed for TCLP SVOCs and TCLP metals.

Table 4-1
Composite Sample Locations - First Floor
Building 3, St. Louis Army Ammunition Plant (SLAAP)
St. Louis, Missouri

Area of Concern											
Traffic Area					Process Area						
CF-A05	CF-B03	CF-C03	CF-H23	CF-K09	CF-B06	CF-D08	CF-E08	CF-F08	CF-G08	CF-H08	CF-J08
CF-A11	CF-B04	CF-D03	CF-H24	CF-K10	CF-B07	CF-D09	CF-E09	CF-F09	CF-G09	CF-H09	CF-J09
CF-A12	CF-B05	CF-E03	CF-H28	CF-K11	CF-B08	CF-D10	CF-E10	CF-F10	CF-G10	CF-H10	CF-J10
CF-A13	CF-B09	CF-F03	CF-H29	CF-K12	CF-C08	CF-D11	CF-E11	CF-F11	CF-G11	CF-H11	CF-J11
CF-A14	CF-B10	CF-F28	CF-H30	CF-K13	CF-C09	CF-D12	CF-E12	CF-F12	CF-G12	CF-H12	CF-J12
CF-A15	CF-B15	CF-F29	CF-H31	CF-K14	CF-C10	CF-D13	CF-E13	CF-F13	CF-G13	CF-H13	CF-J13
CF-A16	CF-B16	CF-F30	CF-H32	CF-K15	CF-C11	CF-D14	CF-E14	CF-F14	CF-G14	CF-H14	CF-J14
CF-A18	CF-B17	CF-F31	CF-H33	CF-K16	CF-C12	CF-D15	CF-E15	CF-F15	CF-G15	CF-H15	CF-J15
CF-A19	CF-B18	CF-F32	CF-H34	CF-K17	CF-C13	CF-D16	CF-E16	CF-F16	CF-G16	CF-H16	CF-J16
CF-A20	CF-B19	CF-F33	CF-H35	CF-K18	CF-C14	CF-D17	CF-E17	CF-F17	CF-G17	CF-H17	CF-J17
CF-A21	CF-B20	CF-G03	CF-H36	CF-K19	CF-C15	CF-D18	CF-E18	CF-F18	CF-G18	CF-H18	CF-J18
CF-A22	CF-B21	CF-G23	CF-H37	CF-K21	CF-C16	CF-D19	CF-E19	CF-F19	CF-G19	CF-H19	CF-J19
CF-A23	CF-B23	CF-G24	CF-H38	CF-K22	CF-C17	CF-D22	CF-E22	CF-F22	CF-G22	CF-H22	CF-J21
CF-A24	CF-B24	CF-G32	CF-J23	CF-K23	CF-C18	CF-D23	CF-E23	CF-F23	CF-G25	CF-H25	CF-J22
CF-A25	CF-B25	CF-G33	CF-J24	CF-K24	CF-C19	CF-D24	CF-E24	CF-F24	CF-G27		CF-K08
CF-A26	CF-B26		CF-J25	CF-K25	CF-C22	CF-D25	CF-E25	CF-F25	CF-G28		
CF-A27	CF-B27		CF-J34	CF-K34	CF-C23			CF-F27	CF-G29		
	CF-B28		CF-J35	CF-K35	CF-C24				CF-G30		
			CF-J36	CF-K36	CF-C25				CF-G31		
			CF-J37	CF-K37							
			CF-J38	CF-K38							

Table 4-2
Composite Sample Locations - Scecond Floor
Building 3, St. Louis Army Ammunition Plant (SLAAP)
St. Louis, Missouri

Area of Concern					
Traffic Area		Process Area			
CF-A17	CF-B09	CF-C09	CF-D09	CF-E09	CF-F09
CF-A18	CF-B10	CF-C10	CF-D10	CF-E10	CF-F10
CF-A19	CF-B11	CF-C11	CF-D11	CF-E11	CF-F11
CF-A20	CF-B12	CF-C12	CF-D12	CF-E12	CF-F12
CF-A21	CF-B13	CF-C13	CF-D13	CF-E13	CF-F13
CF-A22	CF-B14	CF-C14	CF-D14	CF-E14	CF-F14
CF-A23	CF-B19	CF-C18	CF-D18	CF-E18	CF-F18
CF-A24	CF-B20	CF-C19	CF-D19	CF-E19	CF-F19
	CF-B21	CF-C22	CF-D22	CF-E22	CF-F22
	CF-B22	CF-C23	CF-D23	CF-E23	CF-F23
	CF-B23	CF-C24	CF-D24	CF-E24	CF-F24
	CF-B24	CF-C25	CF-D25	CF-E25	CF-F25
	CF-B25				

Figures

0 1

SCALE IN MILES

N

DRAFT

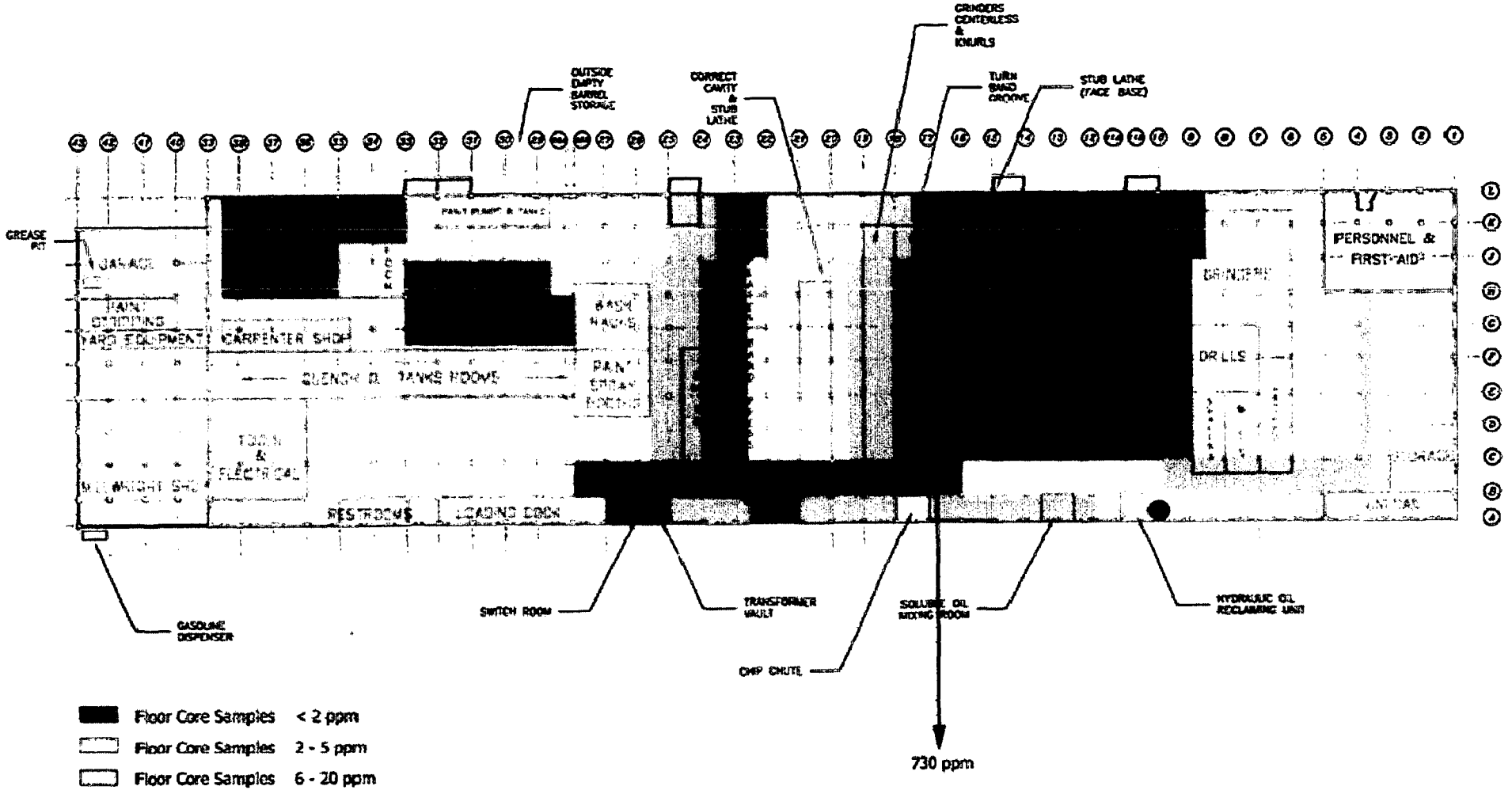
Source: USGS, Clayton, Missouri 7.5' x 15' Quadrangle, 1954, photorevised 1993

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 1-1
SITE LOCATION MAP

Arrowhead Contracting, Inc.

Date: 4/25/01 Project No.: 00-215 SLAAP Drawn By: DLR



- Floor Core Samples < 2 ppm
- Floor Core Samples 2 - 5 ppm
- Floor Core Samples 6 - 20 ppm
- Floor Core Samples 21 - 49 ppm
- Floor Core Samples > 50 ppm
- Wall Core Samples > 2 ppm

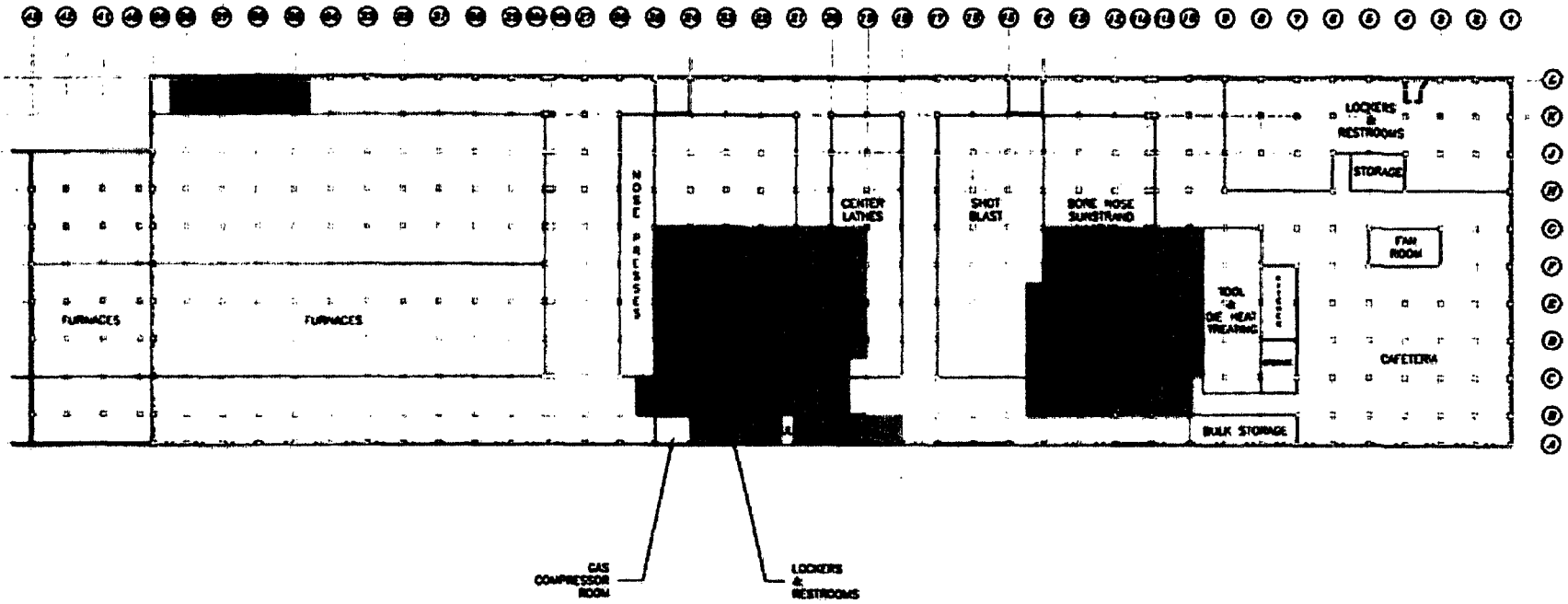
Not to Scale

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 1-2
BUILDING 3, 1ST FLOOR
CONTAMINATION

Arrowhead Contracting, Inc.

Date: 4/27/01 Project No.: 00-215 SLAPP Drawn By:



- Floor Core Samples < 2 ppm
- Floor Core Samples 2 - 5 ppm
- Floor Core Samples 6 - 20 ppm
- Floor Core Samples 21 - 49 ppm
- Floor Core Samples > 50 ppm

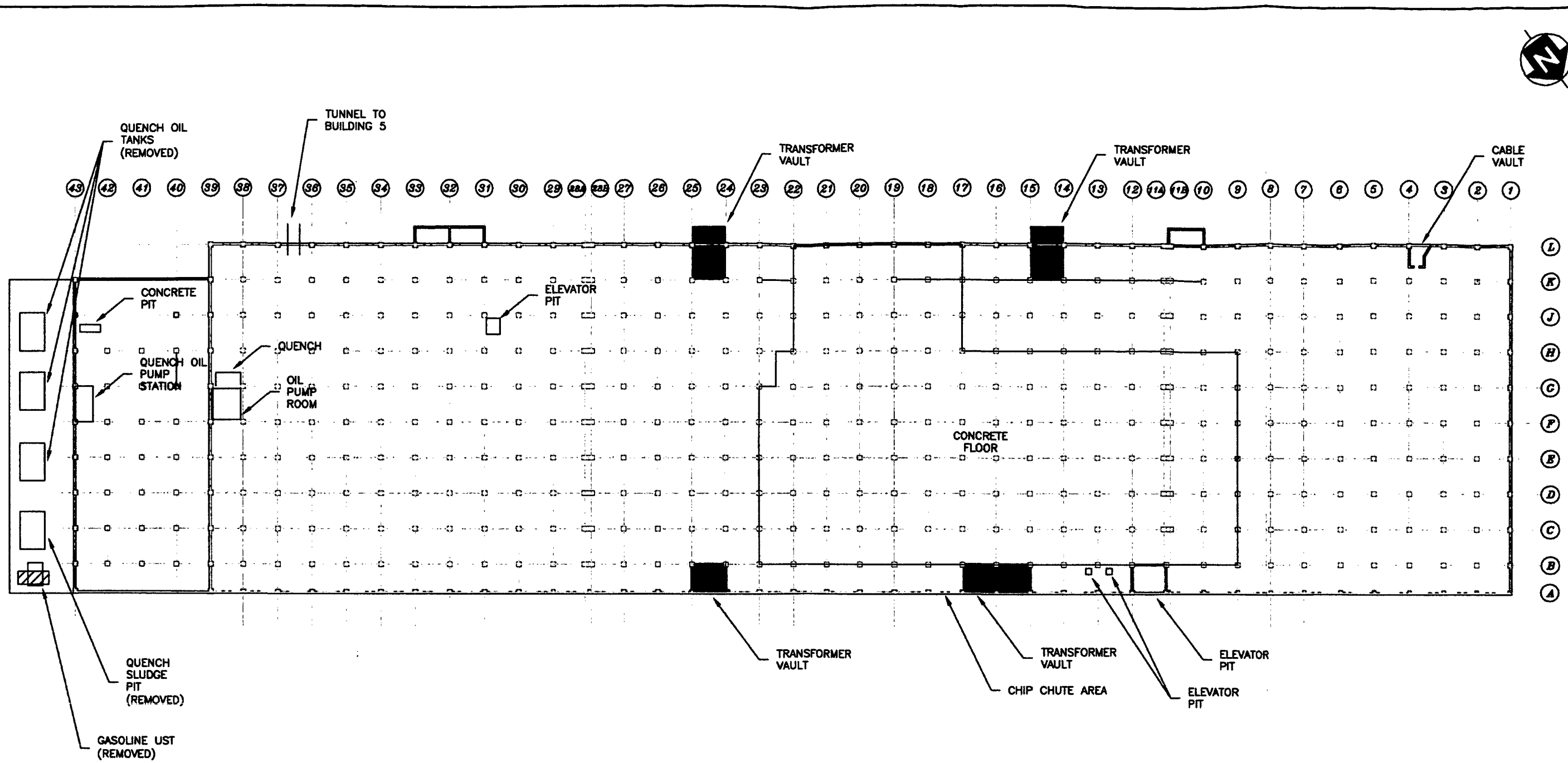
Not to Scale

ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 1-3
BUILDING 3, 2ND FLOOR
CONTAMINATION

Arrowhead Contracting, Inc.

Date: 4/27/01 Project No.: 00-215 SLAPP Drawn By:



LEGEND

AREAS DESIGNATED FOR COLLECTION OF DISCRETE CONCRETE FLOOR SAMPLES

AREAS DESIGNATED FOR COLLECTION OF DISCRETE CONCRETE WALL SAMPLES, WASTE PILE GRAB SAMPLES, DISCRETE CONCRETE FLOOR SAMPLES (IF CONCRETE IS PRESENT BELOW THE WASTE PILE), AND SOIL SAMPLES BELOW THE FLOORING OR WASTE PILE.

NOTES

1. AREAS DESIGNATED FOR CONCRETE SAMPLES FROM MISCELLANEOUS OIL-STAINED AREAS ARE NOT SHOWN. THESE LOCATIONS WILL BE SELECTED IN THE FIELD BASED ON OBSERVATION OF OIL STAINING/SEEPAGE.

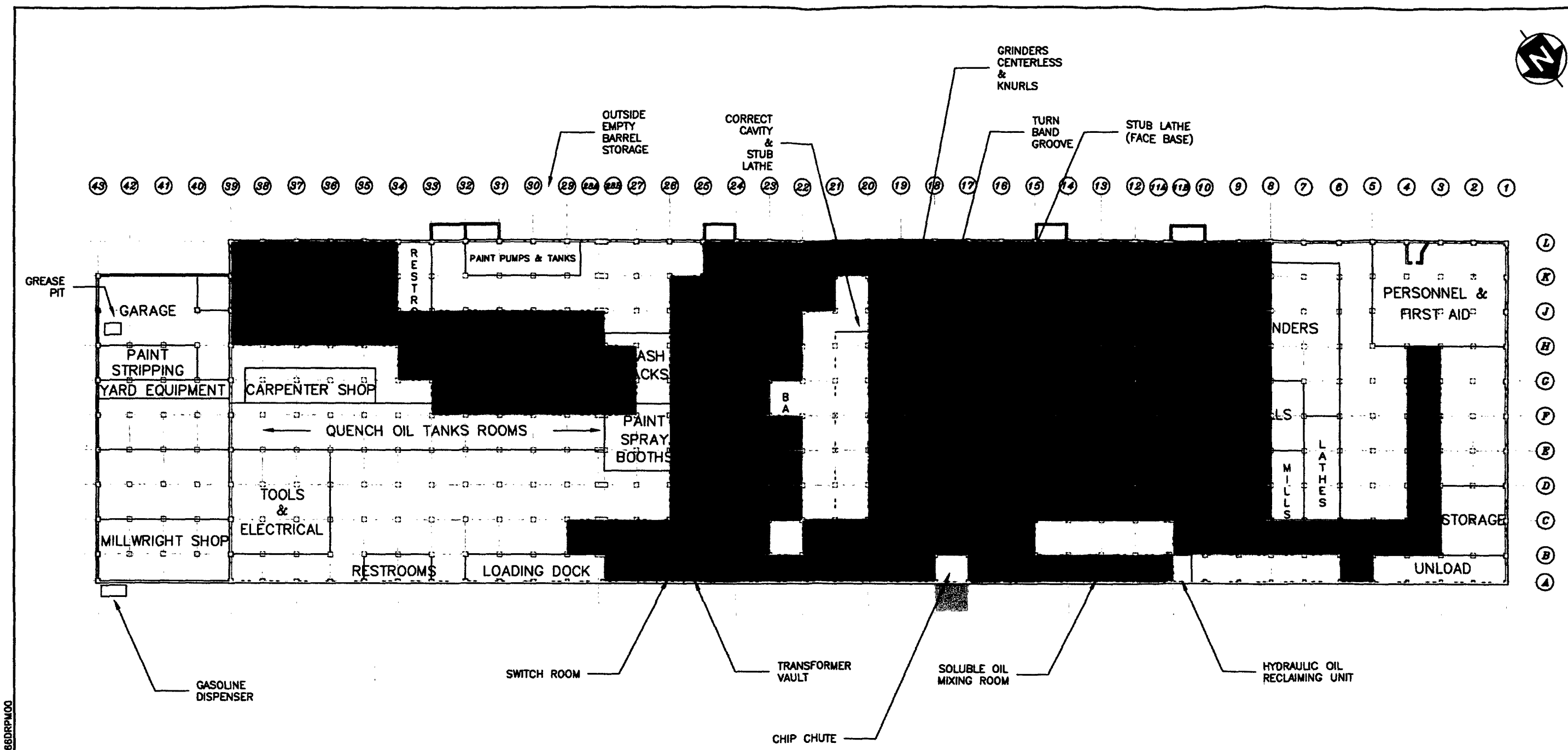
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 3-1
PROPOSED SAMPLING AREAS - BASEMENT

ARROWHEAD CONTRACTING, INC.

DATE: 4/27/01 DESIGNED BY: GWW CHECKED BY: SFS

SLAAP-BLDG3.DWG - 03/15/00 - RAO - G0011.0066DRPM00



LEGEND

- FORMER TRAFFIC AREAS DESIGNATED FOR COLLECTION OF COMPOSITE CONCRETE FLOOR SAMPLES
- FORMER PROCESS AREA DESIGNATED FOR COLLECTION OF COMPOSITE CONCRETE FLOOR SAMPLES
- AREA LOCATED OUTSIDE THE BUILDING ADJACENT TO CHIP CHUTE AREA DESIGNATED FOR COLLECTION OF SOIL SAMPLES

NOTES

1. AREAS DESIGNATED FOR CONCRETE SAMPLES FROM MISCELLANEOUS OIL-STAINED AREAS ARE NOT SHOWN. THESE LOCATIONS WILL BE SELECTED IN THE FIELD BASED ON OBSERVATION OF OIL STAINING/SEEPAGE.

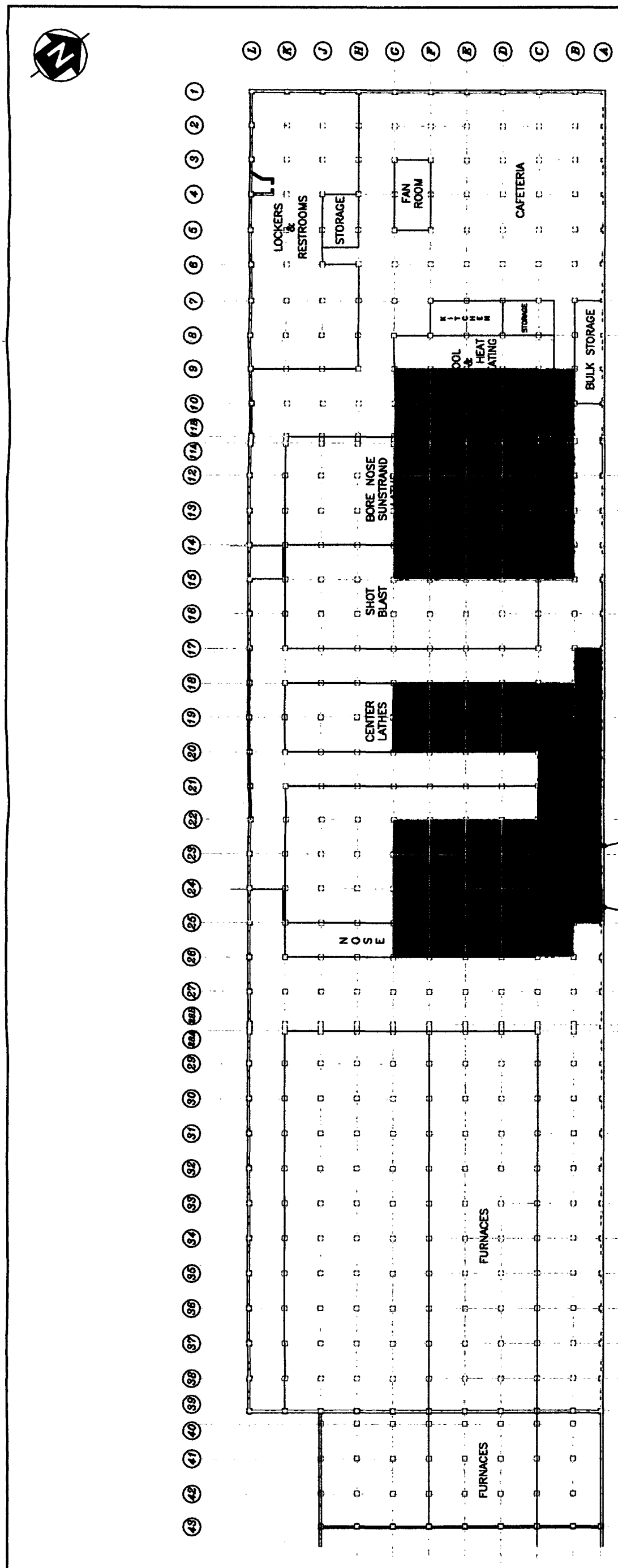
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 3-2
PROPOSED SAMPLING AREAS
FIRST FLOOR

ARROWHEAD CONTRACTING, INC.

DATE: 4/27/01 DESIGNED BY: CMW CHECKED BY: SFS

SLAAP-BLDG3.DWG - 03/15/00 - RAO - G0011.0068DRPM00



ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI

FIGURE 3-3
PROPOSED SAMPLING AREAS
SECOND FLOOR

ARROWHEAD CONTRACTING, INC.

DATE: 4/27/01 DESIGNED BY: CMW CHECKED BY: SFB

NOTES

1. AREAS DESIGNATED FOR CONCRETE SAMPLES FROM MISCELLANEOUS OIL-STAINED AREAS ARE NOT SHOWN. THESE LOCATIONS WILL BE SELECTED IN THE FIELD BASED ON OBSERVATION OF OIL STAINING/SEEPAGE.

LEGEND

FORMER TRAFFIC AREAS DESIGNATED FOR COLLECTION OF COMPOSITE CONCRETE FLOOR SAMPLES

FORMER PROCESS AREAS DESIGNATED FOR COLLECTION OF COMPOSITE CONCRETE FLOOR SAMPLES

SLAAP-BLDG3.DWG - 03/15/00 - RAO - G0011.0066DRPM00

Appendices

(Note: Appendix A is not included with this Draft submittal.)

Part II – Quality Assurance Project Plan

Table of Contents

List of Tables

List of Figures

NONE

List of Appendices

NONE

List of Acronyms

AA	atomic absorption
ASTM	American Society for Testing and Materials
CENWK	Kansas City District Office of the U.S. Army Corps of Engineers Northwest Division
CFR	Code of Federal Regulation
CLP	Contract Laboratory Program
COC	chain-of-custody
DQCR	Daily Quality Control Report
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture detector
ELCD	electrolytic conductivity detector
EPA	Environmental Protection Agency
FADL	Field Activity Daily Log
FSP	Field Sampling Plan
FWV	Field Work Variance
g	gram
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
HNO_3	nitric acid
HPLC	high-performance liquid chromatography
HTRW	Hazardous, Toxic, and Radioactive Waste
ICP	inductively coupled plasma
ICPAES	Inductively Coupled Plasma Atomic Emission Spectroscopy
LCS	laboratory control sample
LIMS	Laboratory Information Management System
LOR	Letter-of-Receipt
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
ppm	parts per million
QA	quality assurance

List of Acronyms *(continued)*

QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SLAAP	St. Louis Army Ammunition Plant
SOP	standard operating procedure
SVOC	semivolatile organic compound
TCLP	Toxicity Characteristic Leachate Procedure
TPP	technical project planning
USACE	U.S. Army Corps of Engineers
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter

1.0 Introduction

This portion (Part II) of the Sampling and Analysis Plan (SAP) consists of the Quality Assurance Project Plan (QAPP). The QAPP will be used to guide analytical and quality assurance/quality control (QA/QC) activities during field work at Building 3 at the Saint Louis Army Ammunition Plant (SLAAP) (refer to Figure 1-1 of the FSP for the location of SLAAP). The United States Army Corps of Engineers (USACE) and the United States Environmental Protection Agency (EPA) require participation in a centrally managed quality assurance (QA) program for environmental monitoring efforts. Any party generating data for an environmental monitoring project has the responsibility to implement procedures to ensure that the data is of adequate quality (in terms of precision, accuracy, representativeness, and completeness) and that the data is appropriately documented. To ensure these responsibilities are met, parities involved in the project must adhere to the requirements specified in this QAPP.

The Field Sampling Plan (FSP) portion (Part I) of this SAP contains detailed descriptions of, among other things, the site layout and history, project scope and objectives, planned sampling activities, sampling rationale, number of samples, and sampling methods. This QAPP (Part II of the SAP) presents a detailed discussion of the analytical and QA/QC activities associated with the Building 3 sampling effort, including data quality objectives, analytical methods, field QA/QC sampling, laboratory QC checks, laboratory calibration procedures, and data validation and reporting. Despite covering different aspects of the project, the contents of each plan are not mutually exclusive. It is intended that the QAPP and FSP be used jointly for purposes of project management.

It should be noted that analytical activities and methodologies associated with analysis of QA split samples to be performed by USACE at a USACE-designated laboratory are not addressed within this document. This QAPP applies to Contractor analytical requirements only. However, the collection of the QA split samples by the Contractor is addressed herein.

The QAPP has been organized into sixteen sections. The contents of each section are summarized below:

- Section 1.0 – Introduction
  - Discusses the general purpose and rationale for development of the QAPP and the relationship of the QAPP to the FSP.

- Section 2.0 – Project Organization and Responsibilities
  - Presents the project organization and responsibilities as they relate to analytical services.

- Section 3.0 – Data Quality Objectives
  - Presents, in general terms, the data quality design process and selection of quality objectives for project data.

- Section 4.0 – Sampling and Analysis Program
  - Presents the type of samples to be collected and the corresponding analyses to be performed.

- Section 5.0 – Sample Containers, Preservation, and Holding Times
  - Presents the requirements for sample containers, preservation, and holding times.

- Section 6.0 – Field QA/QC Samples
  - Presents the types QA/QC samples to be collected during the project, including the frequency of collection.

- Section 7.0 – Analytical Methods
  - Presents a general description of the analytical methods and sample preparation procedures.

- Section 8.0 – Laboratory Calibration Procedures
  - Presents the general procedures for maintaining the accuracy of instruments and equipment used for conducting laboratory analyses.

- Section 9.0 – Laboratory QA/QC Checks
  - Presents details regarding the types of QA/QC samples that will be analyzed to check the performance of the laboratory.

- Section 10.0 – Laboratory Preventative Maintenance
  - Presents a general description of preventative maintenance associated with laboratory instruments and equipment.

- Section 11.0 – Analytical Corrective Actions
  - Presents the corrective actions that will be implemented in the event problems are encountered with analytical equipment or data quality criteria.

- Section 12.0 – Calculation of Data Quality Indicators
  - Presents general descriptions of the methods for assessing project data relative to data quality indicators, including accuracy, precision, completeness and comparability.

- Section 13.0 – Data Reduction, Validation, and Reporting

  - Presents a description of the overall data review process to ensure the validity and usability of project data.

- Section 14.0 – Performance and System Audits
  - Presents a description of the audits that will be conducted to ensure that analytical and QA/QC activities are conducted in accordance with the QAPP.

- Section 15.0 – Quality Assurance Reports to Management
  - Presents details regarding the various types of quality assurance reports that will be prepared and submitted to management during the project.

- Section 13.0 – References
  - Presents a list of references associated with this QAPP.

All QA/QC procedures will be in accordance with applicable professional technical standards, EPA and USACE requirements, government regulations and guidelines, and specific project goals and requirements. This following are the primary references used for the development of this QAPP:

- *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1991)
- *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994a)
- *Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities* (USACE 1998)
- *Requirements for the Preparation of Sampling Analysis Plans* (USACE 1994a).

2.0 Analytical Organization and Responsibilities

The general project organization and responsibilities are presented in Chapter 2.0 of the FSP (referencing Table 2-1). The table lists the CENWK, Contractor, and subcontractor positions that have responsibility for obtaining analytical data for the project. The information presented in this section, provides the organization and responsibilities of the Contractor environmental laboratory(ies) that will provide analytical services under the contract.

Analytical laboratory support specific to the Building 3 sampling effort will be obtained from an independent chemical laboratory. The selected subcontract laboratory shall be validated by USACE. Relevant QA Manuals, laboratory qualification statements, certifications, and license documentation will be made available upon request.

Organization charts outlining the key laboratory personnel and organization will be identified in the QA Plans submitted by the laboratory. The responsibilities of key personnel will also be described in the QA plan. Key analytical personnel include:

- Quality Assurance/Quality Control Manager
- Project Manager
- Laboratory Manager
- Laboratory Technicians and Sample Custodians
- Data Manager

Note: Prior to commencement of field activities for the project, the Contractor will provide a complete copy of the SAP to the subcontract laboratory.

3.0 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements derived from the DQO process that specify, from an end users perspective, the quality of data required to support decisions made during investigative activities. The DQOs specify the maximum level of uncertainty the user is willing to accept in order to accurately make project decisions. DQOs are developed prior to data collection and should be specified for all data collection activities that take place.

3.1 Project Objectives

The underlying objective with respect to data quality is to generate data that is technically sound and legally defensible. In terms of the Building 3 sampling effort, the specific objectives are to:

- Identify areas and volumes of contamination in Building 3 that will be included in a subsequent remedial action.
- Characterize Chip Chute waste pile for eventual removal and disposal.
- Characterize Building 3 structural materials for subsequent off-site waste disposal during remediation.
- Characterize soils beneath/adjacent to Chip Chute Area for subsequent disposal (if necessary) during remediation.
- Determine the chemical composition of Building 3 materials for assessing personnel exposure and safety concerns during remediation.
- Characterize investigation-derived waste (IDW) (decontamination water) to determine proper disposal methods.

This is to be accomplished through the proper implementation of the field sampling procedures, chain of custody (COC) documentation, controlled laboratory analysis, and validation of the reported data prior to their use. The necessary procedures for field sampling and COC are discussed in FSP. Procedures for laboratory analysis and data validation are discussed in other sections of this QAPP.

3.2 Data Quality Design Process

As described in the USACE Engineering Manual, EM 200-1-2, *Technical Project Planning (TPP) Process* (USACE 1998), the data quality design process is basically a four-phase process performed to identify the data needed to support specific project decisions and to create a data collection program to collect the necessary data. The DQOs generated as a result of the TPP process are project-specific statements that incorporate nine data quality requirements:

1. Project objective(s) satisfied
2. Data user perspective(s) satisfied
3. Contaminant or characteristic of interest identified
4. Media of interest identified
5. Required sampling areas or locations and depths identified
6. Number of samples required
7. Reference concentration of interest or other performance criteria identified
8. Sampling method identified
9. Analytical method identified

Most of these requirements are addressed in Section 3.0 of the FSP. The remaining requirements are addressed in this QAPP. A general summary of the DQO design process for the Building 3 project is presented in Table 3-1.

3.2.1 Identify Current Project Strategy

The first phase of the TPP process brings together decision-makers and technical personnel (e.g., customer, data users, and regulators) to identify an overall strategy to manage a site from its current condition to the desired closeout condition. Integral to development of a strategy for the site is establishing both short- and long-term objectives for the project. These objectives are the driver for collecting data. The overall strategy for the Building 3 project is discussed in detail in the FSP. Project objectives are presented in Section 3.1.

3.2.2 Determine Data Needs

Following establishment of the project strategy and objectives, data needs are identified commensurate with the expectations of the end-users of the data, such that the level of data quality will satisfy all project objectives. During this phase, technical personnel evaluate existing data, if any, and define the media-type, chemical requirements and numbers of samples necessary to statistically support the data users decision making process. Considerations include:

- Data needed to satisfy project objectives
- Data user
- Intended use of data
- Number of samples necessary to satisfy intended use
- Reference concentration of analyte of interest
- Area of interest or desired sampling location(s) and depth(s).

The data needs for the Building 3 project, including the areas of interest (concern), sampling locations, sample depths, and types and number of samples, is presented in Section 3.0 of the FSP (referencing Tables 3-1 through 3-4). Table 3-1 of the QAPP summarizes the data needs and presents the analytes of interest for the project.

3.2.3 Develop Data Collection Options

The next phase of the TPP is to design and plan the sampling and analysis activities necessary to fulfill the data needs. During this phase, the collection options are developed. Technical personnel document the requirements for data collection options, including the appropriate sampling and analysis methods. The documentation process must include:

- Data needs being met
- Project objectives to be satisfied
- Number of samples are to be collected
- Locations from where the samples are to be collected
- Sample collection methods to be used
- Sample analysis methods to be used
- List limitations, benefits or requirements associated with each data collection option.

This phase of the DQO design process was discussed in detail in Sections 3.0 and 4.0 of the FSP.

3.2.4 Finalize Data Collection Program

This final phase is to create a data collection program that best fits the short-term and long-term objectives. The design of the data collection program is performed by the PM, key data users, and data implementors and should include the regulators and stakeholders to ensure representation of all key data needs. The type and frequency of samples to be collected, as well as definition with respect to the data collection options will be identified during this phase. Additionally, project-oriented DQO statements are prepared that describe the intended data use(s), the data need requirements, and the means to achieve them. Table 3-1 presents the DQO statements for the Building 3 project. The overall sampling and analysis program resulting from the DQO design process is discussed in Section 4.0.

3.3 Quality Assurance Objectives for Analytical Data

The final step in establishing the DQOs is to determine the analytical data quality indicators (DQIs). The primary DQIs include precision, accuracy, completeness, sensitivity, representativeness, and comparability. The laboratory chosen to perform the analytical work will

provide their laboratory quality assurance plan, which shall include the Standard Operating Procedures (SOPs) and laboratory-specific quality control limits for all contracted parameters. Based on the SOPs, the Contractor shall ensure that the laboratory is capable of complying with project-specific DQIs. A detailed discussion of the methods for calculating the primary DQI parameters is found in Section 12.0 of this QAPP. The DQI parameters are defined as follows:

- **Precision** – Precision is determined and reported as the relative percent difference (RPD) between the results for field duplicates and/or between the results for matrix spike/matrix spike duplicate (MS/MSD) samples. Data with acceptable quality shall meet the precision criteria presented in Tables 7-2, 7-4, 7-6, and 7-7.

- **Accuracy** – Accuracy is determined and reported as the percent recovery from the analysis of a reference material, MS/MSD, and /or laboratory control sample (LCS). Data with acceptable quality shall meet the accuracy criteria presented in Tables 7-2. 7-4. 7-6, and 7-7.

- **Completeness** – Completeness is determined for separate but integrated functions.
  - *Sample Collection Completeness* is calculated by comparing the number of samples actually collected in the field to the number of samples planned to be collected. Acceptance criteria for sample collection completeness shall be 95%.
  - *Acceptable Data Completeness* is defined as the percentage of useable data versus the total amount of data generated. Acceptable data are generated following a review (validation) of the data using the analytical method criteria (SW-846). Acceptable data are all data which have completed the review or validation process and have not been rejected. Acceptance criteria for acceptable data completeness shall be 95% for each analytical method defined in this QAPP.
  - *Quality Data Completeness* is defined as the percentage of quality data versus the total set of data. Quality data are analytical data obtained from a sample delivery group which meet all batch quality control criteria. Completeness criteria for quality data shall be 80%.

- **Sensitivity** is a quantitative reflection of the method detection limit (MDL) and/or reporting limit (RL) (or practical quantitation limit) calculated by the analytical laboratory in accordance with 40 CFR Part 136 Appendix B. Project-required RLs are presented in Tables 7-1, 7-3, 7-5, and 7-7.

- **Representativeness/Comparability** - Representativeness and comparability are both qualitative statements about the data which can provide quality data if the sampling set is adequately prepared and standard method of analysis are used for chemical analysis.

4.0 Sampling and Analysis Program

Based on the DQO design process discussed in Section 3.0, a project-specific sampling and analysis program was developed and is summarized in Table 4-1. The sampling effort performed at Building 3 will involve collection of samples for the following purposes consistent with the project objectives:

- Samples collected for PCB identification
- Samples collected for remediation waste characterization
- Samples collected for health and safety characterization
- Samples collected for IDW characterization

This sampling program will involve the collection of samples from the following media type:

- Concrete
- Soil
- Waste pile material (Chip Chute)
- IDW water samples

Areas of the Building 3 to be sampled are identified on Figures 3-1, 3-2, and 3-3 of the FSP. The rationale for the selection of these areas is discussed in detail in Section 3.0 of the FSP. Sampling methods are discussed in Section 4.0 of the FSP. Estimates of the number of samples to be collected by media type are presented in Table 4-1. Additional portions of select samples will be collected to meet QA/QC requirements, including duplicates, QA split samples, and field blanks as discussed in Section 6.0. Estimates of the number of QA/QC samples to be collected are presented in Table 6-1.

Samples will be analyzed for the following parameters:

- PCBs
- Total Metals
- Total semivolatile organic compounds (SVOCs)
- Toxicity Characteristic Leaching Procedure (TCLP) Metals
- TCLP SVOCs

The SW-846 methods associated that will be used to analyze samples for these parameters are presented in Table 4-1, and are discussed in further detail in Section 7.0. Sample container,

sample volume, preservation and holding time requirements for the analytical parameters are discussed in Section 5.0 and presented in Tables 5-1, 5-2, and 5-3.

5.0 Sample Containers, Preservation, and Holding Times

Sample containers, chemical preservation techniques, and holding times for concrete, soil, waste pile, and water samples collected during the Building 3 sampling effort are presented in Tables 5-1, 5-2, and 5-3. The specific number of containers required for this study will be estimated and supplied by the subcontracted analytical laboratory. When required by the analytical laboratory, additional sample volumes will be collected and provided for laboratory QC samples (laboratory duplicates, MS/MSD).

All sample containers will be provided by the analytical laboratory, which will also provide the required types and volumes of preservatives for the sample containers. Temperature preservation will be maintained at 4 C (±2 C) immediately after collection and will be maintained within this temperature range until the samples are analyzed. In the event that sample integrity, such as holding times, cooler temperatures, etc., is compromised, re-sampling will occur as directed by the CENWK Project Manager. Any affected data will be flagged and qualified per data validation instructions and guidance.

6.0 Field QA/QC Samples

Quality assurance/quality control (QA/QC) samples are analyzed for the purpose of assessing the quality of the sampling effort and of the reported analytical data. QA/QC samples to be used for the Building 3 project include field duplicates, USACE split samples, equipment rinsate blanks, and MS/MSD samples. Table 6-1 presents a summary of the field QA/QC sampling program, including the frequencies at which the samples will be collected and analyzed.

6.1 Field Duplicates

These samples are collected by the sampling team for analysis by the subcontractor laboratory. The purpose of these samples is to provide site-specific, field-originated information regarding the homogeneity of the sampled matrix and the consistency of the sampling effort. These samples are collected concurrently with the primary samples at the same time and location. Duplicate samples will be collected from each media type and submitted to the subcontractor laboratory for analysis. Duplicates will be collected at a frequency of 10% of the total planned field samples.

6.2 USACE Split Samples

These samples are collected by the sampling team and sent to a USACE QA laboratory for analysis. Split samples provide an independent assessment of the subcontractor laboratory performance. The Contractor will coordinate with the designated QA laboratory not less than 48 hours before sampling to ensure that the laboratory is alerted to receive the QA samples and process them within required holding times. Split samples will be collected at frequency of 10% of the total planned field samples.

6.3 MS/MSD Samples

MS and MSD project samples that are "spiked" by laboratory with known quantities of analytes. The spiked samples are then and subjected to the entire analytical procedure. The MS is used to verify the accuracy of the analytical method (for a particular matrix) by measuring percent recovery of the analyte. The MSD is used to assess the precision of the analytical method. To meet MS/MSD requirements, the laboratory typically needs additional volume of the sample collected in the field. If requested by the laboratory, MS/MSD samples will be collected at a frequency of 20% of the total planned field samples.

6.4 Equipment Rinsate Blanks

These samples will be taken from the water rinsate collected during equipment decontamination activities. Rinsate blank samples will consist of "clean" (analyte-free) water used as a final rinse of decontaminated sampling equipment. They will be collected and submitted for analysis of the parameters of interest. Equipment rinsate blanks are used to assess the effectiveness of the decontamination process, the potential for cross contamination between sampling locations, and incidental field contamination. Equipment rinsate blanks will be collected at a frequency of 20% of the total planned samples.

7.0 Analytical Methods

Samples collected during the Building 3 sampling effort will be analyzed by the subcontractor laboratory. This laboratory will be validated by USACE. QA samples shall be collected and analyzed by the designated USACE QA Laboratory.

The subcontractor laboratory supporting this work shall provide statements of qualifications including organizational structure, QA Manual, and standard operating procedures (SOPs). Laboratory standard operating procedures are based on the methods as published by the EPA in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW846*, Third/Fourth Edition (November 1986; Revision 1, July 1992; Revision 2, November 1992; and Updates 1, 2, and 3). These SOPs must be adapted from and reference standard EPA SW-846 methods and thereby specify:

- Procedures for sample preparation
- Instrument start-up and performance check
- Procedures to establish the actual and required detection limits for each parameter
- Initial and continuing calibration check requirements
- Specific methods for each sample matrix type
- Required analyses and QC requirements

Samples collected during the project will be analyzed by EPA SW-846 methods. The analytes of interest and the corresponding SW-846 methods to be used for this project are presented in Table 3-1. The primary SW-846 methods include:

- Method 80802 – PCBs
- Method 8270C – SVOCs
- Method 6010B – Metals (except mercury)
- Method 7470A/74741A - Mercury

Tables 7-1 though 7-7 present the reporting limits and precision and accuracy limits for each of the primary analytical methods.

If contaminant concentrations are high, or if matrices (other than normal waters and soils) create a problematic effect on the analysis, analytical protocols may require modifications to defined methodology. Any proposed changes to standard analytical methods require written approval from the Contractor and CENWK. All analytical method variations will be identified in project

addenda. These may be submitted for regulatory review and approval when directed by the CENWK Project Manager.

7.1 Preparation Procedures

Extraction and digestion procedures for the preparation of solid and liquid matrices will include the following:

- **Method 1311 - Toxicity Characteristic Leaching Procedure (TCLP)**: Method 1311 is used to prepare samples for the determination of the concentration of organic and inorganic constituents that are leachable from waste or other material.

- **Method 3005A - Acid Digestion of Water Samples for Metals Analysis**: Method 3005A consists of an acid digestion procedure to prepare aqueous samples for metals analysis. The digested samples are analyzed for total recoverable and dissolved metals determination by inductively couple plasma spectroscopy (ICP).

- **Method 3010A - Acid Digestion of Aqueous Samples and Extracts for Metals Analysis**: Method 3010A prepares aqueous or waste samples for total metals determination by ICP.

- **Method 3540/3541 - Soxhlet Extraction**: Method 3540/3541 is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. Method 3541 is an automated Soxhlet extraction. The soxhlet extraction process ensures intimate contact of the sample matrix with the extraction solvent.

- **Method 3580A – Waste Dilution**: This method involves a solvent dilution of a non-aqueous waste sample prior to analysis. This method is used in combination with Method 1311 for preparing samples for TCLP analysis.

7.2 Analytical Procedures

Analytical methods for solid and water matrices associated with this project will include:

- **Method 8082 – Polychlorinated Biphenyls (PCBs) by Gas Chromatography**: Method 8082 is used to determine the concentrations of PCBs as Aroclors or as individual PCB congeners in extracts from solid and aqueous matrices. Open-tubular, capillary columns are employed with electron capture detectors (ECD) or electrolytic conductivity detectors (ELCD).

- **Method 8270C - Semivolatile Organic Compounds (SVOCs)**: Semivolatile organic compounds (also known as base-neutral and acid extractables) in water and soil samples are analyzed using method Method 8270C. This technique quantitatively determines the concentration of a number of SVOCs. Samples are solvent extracted and concentrated

through evaporation of the solvent. Compounds of interest are separated and quantified using a capillary column GC/mass spectrometer.

- **Method 6010B - Trace Metals by Inductively Coupled Plasma Atomic Emission Spectroscopy for Water and Soils**: Samples are analyzed for trace metals using Method 6010B for water and soils. Analysis for most metals requires digestion of the sample. Following digestion, the trace elements are determined simultaneously or sequentially using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES).

- **Method 7470A/7471A- Mercury Manual Cold-Vapor Technique**: Water and soil samples are analyzed for mercury using methods SW7470A and SW7471A, respectively. This method is a cold-vapor, flameless atomic absorption (AA) technique based on the absorption of radiation by mercury vapor.

8.0 Laboratory Calibration Procedures

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment that are used for conducting laboratory analyses. These instruments and equipment shall be calibrated before each use or on a scheduled, periodic basis according to manufacturer instructions.

8.1 Analytical Support Areas

The following sections discuss the calibration needs for operations within the analytical laboratory necessary to support the instrumentation.

8.1.1 Analytical Standards

All primary reference and secondary working standards used for the purpose of instrument calibration and recovery determinations must be traceable to National Institute of Standards and Technology (NIST) or EPA sources. The preparation and use of these standards must be documented in a standards log book which shall include the preparers name, date of preparation, and date of expiration and storage location.

8.1.2 Laboratory Balances

All balances to be used for sample weights and/or standards preparation must receive an annual manufacturer's calibration. The balance must be calibrated daily with a minimum of two class "S" weights which bracket the range of weights to be determined. A hardbound balance logbook must be maintained with the results of the daily calibrations.

8.1.3 Laboratory Refrigerators/Freezers

All cold storage units (for both samples and standards) must be monitored daily for proper use. The acceptable working range of the unit must be clearly posted on the unit's front panel. All thermometers used for monitoring must be immersion type and be calibrated versus a certified thermometer on a yearly basis.

8.1.4 Laboratory Water Supply

The laboratory water unit shall be capable of supplying sufficient quantities of American Society for Testing and Materials (ASTM) Type II reagent water (resistivity of >1 megohm-cm @25 C) to the required analytical areas. Recommendations for "polishing" water for analytical use are ion-exchange units for inorganic analyses and distillation/deionization followed by UV treatment

or carbon absorption for organic analyses. Conductivity or resistance reading of the system water shall be documented minimally daily or greater dependant upon the water usage.

8.2 Laboratory Analytical Instrumentation

Details regarding the procedures for calibration of laboratory equipment and maintenance of calibration records will be presented in laboratory QA Plans and/or SOPs. These procedures will be reviewed by the Contractor and USACE prior to the start of sampling and analysis activities. For all analyses conducted according to SW-846, the calibration procedures and frequencies specified in the SW-846 methods will be followed. Tables 8-1 through 8-4 present a summary of the standard calibration procedures for the project-specific analytical methods.

Records of calibration will be kept as follows:

- Each instrument will have a record of calibration with an assigned record number.
- A label will be affixed to each instrument showing identification numbers, manufacturer, model numbers, date of last calibration, signature of calibrating analyst, and due date of next calibration. Reports and compensation or correction figures will be maintained with instrument.
- A written step-wise calibration procedure will be available for each piece of test and measurement equipment.
- Any instrument that is not calibrated to the manufacturer's original specification will display a warning tag to alert the analyst that the device carries only a "Limited Calibration."

Records of calibration, repairs, or replacement will be filed and maintained by laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit.

9.0 Laboratory QA/QC

The subcontractor laboratory will have a written QA program that provides guidelines to ensure the reliability and validity of work conducted at the laboratory. The objectives of the laboratory QA program will be to:

- Properly collect, preserve, and store all samples
- Maintain adequate custody records from sample collection through reporting and archiving of results
- Use properly trained analysts to analyze all samples by approved methods within holding times
- Produce defensible data with associated documentation to show that each system was calibrated and operating within precision and accuracy control limits
- Accurately calculate, check, report, and archive all data using the Laboratory Information Management System (LIMS)
- Document all the above activities so that project data can be independently validated.

Laboratory QA Plans will be appropriately referenced and implemented in their entirety. Compliance with the QA program will be coordinated and monitored by the laboratory's QA department, which is independent of the operating departments.

To ensure the production of analytical data of known and documented quality, the subcontractor laboratory will implement method and batch QC checks as described below. Internal quality control checks are generated by the analytical laboratory and are used to determine whether an analytical operation is in control or if the sample matrix has an effect on the data being generated. Internal QC measures for analysis will be conducted in accordance with SOPs and the individual method requirements. The minimum QC requirements for all methods proposed for use at Building 3 are presented in Tables 8-1 through 8-4, including the types of QC checks, the frequency for implementation of each QC measure, and the acceptance criteria for the QC check.

The laboratory will provide documentation in each data package that both initial and ongoing instrument and analytical QC functions have been met. Any non-conforming analysis will be reanalyzed by the laboratory, if sufficient sample volume is available. It is expected that sufficient sample volumes will be collected to provide for re-analyses, if required.

9.1 Batch Quality Control

Sample batch QC can either be associated with sample preparation or with the analytical determination. In either case, the batch is not to exceed twenty samples of similar matrix. The *preparation batch* is the set of samples, which are extracted or digested together by the same lab technician, with the same lot of reagents, over the same time. All the samples within the same preparation batch must be of the same matrix, and the batch must have its own unique method blank and QC samples as defined below. The *analytical batch* is the group of samples that are analyzed together during the same analytical sequence within one continuous time period. The analytical batch can consist of multiple preparation batches but must analyze all constituents of the preparation batch. QC cannot be run separate from the analytical samples.

9.1.1 Method Blanks

There are two types of method blanks –instrument blanks and preparation blanks. An instrument blank is an aliquot of pure, non-contaminated reagent (i.e. reagent water) that is analyzed prior to samples to establish background levels of the analytical system. The preparation blank is a sample of a pure, non-contaminated matrix of interest (usually reagent grade water or purified silica sand) that is subjected to all of the sample preparation (digestion, distillation, extraction) and analytical methodology applied to the samples. The preparation blank is used to assess the level of background contamination which might affect low level concentration results. The affect could be either false positive results or biased high low concentration results. Method blanks must be prepared and analyzed with each analytical sample batch.

Analytical sensitivity goals are identified in Tables 7-1, 7-3, 7-5 and 7-7 as reporting limits. Method blank levels should be below these levels for all analytes. Contamination levels reported in the blanks are never subtracted from the concentration of the sample.

9.1.2 Laboratory Control Samples (LCS)

The LCS contains known concentrations of analytes representative of the contaminants to be determined and is carried through the entire preparation and analysis process. The primary purpose of the LCS is to establish and monitor the laboratory's analytical performance control. Commercially available LCSs or those from EPA may be used. LCS standards prepared in-house must be made from a source independent of that of the calibration standards. An LCS must be analyzed with each analytical sample batch. The results (as percent recovery) for each LCS analyte must be plotted on a control chart.

9.1.3 Laboratory Duplicates

Laboratory duplicates are separate aliquots of a single sample that are prepared and analyzed concurrently at the laboratory. This duplicate sample shall not be a method blank, trip blank, or field blank. The primary purpose of the laboratory duplicate is to check the precision of the laboratory analyst, the sample preparation methodology, and the analytical methodology. If there are significant differences between the duplicates, the affected analytical results will be re-examined. One in 20 samples will be a laboratory duplicate, with fractions rounded to the next whole number.

9.1.4 Surrogate Spikes

A surrogate spike is prepared by adding a pure compound to a sample before extraction. The compound in the surrogate spike should be of a similar type to that being assayed in the sample. The purpose of a surrogate spike is to determine the efficiency of recovery of analytes in the sample preparation and analysis. The percent of recovery of the surrogate spike is then used to gauge the total accuracy of the analytical method for that sample. The frequency for performing surrogate spikes is dependent on the analytical method.

9.1.5 Matrix Spikes and Matrix Spike Duplicates

An MS is an aliquot of a sample spiked with known quantities of analytes and subjected to the entire analytical procedure. It is used to indicate the appropriateness of the method for the matrix by measuring recovery. An MSD is a second aliquot of the same sample with known quantities of compounds added. The purpose of the MSD is to evaluate method precision. MSs and MSDs are performed at a frequency of one per 20 samples of similar matrix.

9.2 Method-Specific Quality Control

The laboratory must follow specific quality processes as defined by the analytical method. These will include measures such as calibration verification samples, instrument blank analysis, internal standards implementation, method of standard additions utilization, serial dilution analysis, post-digestion spike analysis, etc.

10.0 Laboratory Preventative Maintenance

As part of the laboratory's QA/QC program, a routine preventive maintenance program will be implemented to minimize the occurrence of instrument failure and other system malfunctions. All laboratory instruments will be maintained in accordance with manufacturers' specifications and the requirements of the specific method employed. This maintenance will be carried out on a regular, scheduled basis and will be documented in the laboratory instrument service log book for each instrument. Emergency repair or scheduled manufacturer's maintenance will be provided under a repair and maintenance contract with factory representatives. Table 10-1 of this QAPP provides typical maintenance items for select equipment associated with this project; however; this table is not intended to be inclusive of all required preventative maintenance procedures. The subcontractor laboratory shall provide written preventative maintenance in the laboratory-specific QA Plan and/or SOPs.

11.0 Analytical Corrective Actions

Corrective actions may be required for two major types of problems: analytical/equipment problems and noncompliance with acceptance criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

The laboratory-specific QA plan shall provide systematic procedures to identify laboratory related out-of-control situations and corrective actions. Corrective actions shall be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel will have received QA training and will be aware that corrective actions are necessary when:

- QC data are outside warning or control windows for precision and accuracy
- Blanks contain target analytes above acceptable levels and must be investigated
- Undesirable trends are detected in spike recoveries or RPD between duplicates
- There are unusual changes in detection limits
- Deficiencies are detected by internal audits, external audits, or from performance evaluation samples results
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, prepares spike and calibration mixes, checks instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with project records and the QA Department, and the information is summarized within case narratives.

Typical analytical corrective actions include:

- Re-analyzing the samples, if holding time criteria permit
- Evaluating blank contaminant sources, elimination of these sources, and reanalysis
- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation
- Re-sampling and analyzing
- Evaluating and amending sampling procedures
- Accepting data and acknowledging the level of uncertainty.

If re-sampling is deemed necessary due to laboratory problems, the Contractor and CENWK Project Manager will evaluate the costs/benefits of implementing the additional sampling effort.

11.1 Incoming Samples

Problems noted during sample receipt will be documented in the appropriate laboratory letter-of-receipt (LOR). The Contractor and CENWK Project Manager will be contacted immediately to determine resolution to the problem. All corrective actions will be thoroughly documented.

11.2 Sample Holding Times

When sample extraction/digestion or analytical analyses are not performed within method required holding times, the Contractor and CENWK Project Manager will be notified immediately to determine problem resolution. All corrective actions will be thoroughly documented.

11.3 Instrument Calibration

Project samples shall not be analyzed by instrumentation which fails to meet tuning and/or standardization/calibration criteria as presented in Tables 8-1 through 8-4. All project samples will be reanalyzed if performed following an initial and/or continuing calibration analytical sequence that does not meet method requirements. Corrective action may require standard re-preparation, instrument maintenance, and instrument recalibration /restandardization.

11.4 Reporting Limits

All appropriate measures shall be required to prepare samples in an attempt to achieve the reporting limits as stated in Tables 7-1, 7-3, 7-5, and 7-7. When difficulties arise in achieving these limits, the laboratory will notify the Contractor and CENWK Project Manager to determine problem resolution. All corrective actions shall be thoroughly documented.

Any dilutions impacting the reporting limits will be documented in case narratives along with revised reporting limits for those analytes affected. Analytes detected above the method detection limits, but below the reporting limits, will be reported as estimated values. Both the undiluted and diluted set of data shall be provided to the Contractor.

11.5 Method Quality Control

Failure of method-required QC to meet the requirements specified on Tables 8-1 through 8-4 of this QAPP shall require corrective actions for all affected data. The Contractor and CENWK Project Manager will be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.

11.6 Calculation Errors

When calculation or reporting errors are noted within any given data package, reports will be reissued with applicable corrections. Case narratives will clearly state the reasons for reissuance of reports.

12.0 Calculation of Data Quality Indicators

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, sensitivity and representativeness/comparability as outlined in the following sections.

12.1 Precision

The precision of the laboratory analytical process will be determined through evaluation of the comparative determination of the LCS and LCSD, the MS and MSD, and/or the sample and sample duplicate analyses. Investigative sample matrix precision will be assessed by comparing the analytical results between MS/MSD for organic analysis and laboratory duplicate analyses for inorganic analysis. (MS/MSD pairs may also be prepared for inorganic analyses). The RPD will be calculated for each pair of duplicate analysis using appropriate formulas in Table 12-1 and produce an absolute value for RPD. This precision measurement will include variables associated with the analytical process, influences related to sample matrix interferences, and sample heterogeneity.

12.2 Accuracy

The accuracy of the laboratory analytical measurement process will be determined by comparing the percent recovery for the LCS / LCSD versus its documented true value. Overall project accuracy includes the assessment of investigative sample using the analytical results of MS and MSD samples. The percent recovery (%R) of LCS and MS/MSD samples will be calculated using the appropriate formula in Table 12-1. This overall accuracy will include variables associated with the analytical process, influences related to sample matrix interferences, and sample heterogeneity.

12.3 Data Completeness

Data completeness of laboratory analyses will be assessed for compliance with the amount of data required for decision making. The completeness is calculated using the following equation:

$$\%\ Completeness = \frac{Number\ of\ valid\ results\ (non\text{-}R\ flagged)}{Number\ of\ possible\ results} \times 100$$

Completeness objectives were defined in Section 3.3.

12.4 Project Completeness

Project completeness will be determined by evaluating the planned versus actual data. Consideration will be given for project changes and alterations during implementation. All data not flagged as rejected by the review, verification, validation, or assessment processes will be considered valid. Overall, the project completeness will be assessed relative to media, analyte, and area of investigation. Completeness objectives were defined in Section 3.3.

12.5 Sensitivity

Sensitivity of the analytical determination is directly related to the laboratory's MDL or RL (or practical quantitation limit). Achieving MDLs/RLs depends on sample preparation techniques, instrumental sensitivity, and matrix effects. Therefore, it is important to determine actual MDL/RL through the procedures outlined in 40 CFR 136, Appendix C. MDLs/RLs should be established for each major matrix under investigation (i.e., concrete, soil, water) through multiple determinations, leading to a statistical evaluation of the MDL.

It is important to monitor instrument sensitivity through calibration blanks and low concentration standards to ensure consistent instrument performance. It is also critical to monitor the analytical method sensitivity through analysis of method blanks, calibration check samples, and LCSs, etc.

12.6 Representativeness/Comparability

Representativeness expresses the degree to which data accurately reflect the analyte or parameter of interest for the environmental media examined at the site. It is a qualitative term most concerned with the proper design of the sampling program. Factors that affect the representativeness of analytical data include appropriate sample population definitions, proper sample collection and preservation techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences. Sample collection, preservation, analytical holding time, analytical method application, and matrix interferences will be evaluated by reviewing project documentation and QC analyses.

Comparability, like representativeness, is a qualitative term relative to the confidence of how one project data set compares with another. The comparability issue is controlled through the use of defined sampling methodologies, use of standard sampling devices, standard analytical protocols/procedures, and QC checks with standard control limits. Through proper implementation and documentation of these standard practices, the project will establish confidence that data will be comparable to other project and programmatic information.

Additional input to determine representativeness and comparability may be gained through statistical evaluation of data populations, chemical charge balances, compound evaluations, or dual measurement comparisons.

13.0 Data Validation, Reduction, and Reporting

This chapter describes the data review process enacted to ensure validity of the analytical data. All data generated by the analytical laboratory will be initially reviewed by the laboratory technical personnel prior to being submitted to the Contractor. This review will provide a check to ensure the correctness of the reported results and generate a case narrative to explain any anomalies which may affect the validity or useability of the data. Following receipt of the data package, the electronic data will be validated by the database and the hardcopy data will be validated by the Contractor chemists or designees.

13.1 Data Reduction

Data reduction requirements apply to both field data and laboratory-generated data.

13.1.1 Field Data

Raw data from field measurements and sample collection activities will be appropriately recorded in field logbooks. Data to be used in project reports will be reduced and summarized. The methods of data reduction will be documented.

The Contractor Project Manager or designee is responsible for data review of all field-generated data. This includes verifying that all field descriptive data are recorded properly, that all field instrument calibration requirements have been met, that all field QC data have met frequency and criteria goals, and that field data are entered accurately in all logbooks and worksheets.

13.1.2 Laboratory Data

All samples collected for the project will be sent to a USACE-approved laboratory. Data reduction, evaluation, and reporting of samples analyzed by the laboratory will be performed according to specifications outlined in both the laboratory's QA plan and this QAPP. Laboratory reports will include documentation verifying analytical holding time compliance.

The laboratory will perform in-house analytical data reduction under the direction of the Laboratory QA Manager. The Laboratory QA Manager or designee are ultimately responsible for assessing data quality and informing the Contractor and CENWK of any data which are considered "unacceptable" or require caution on the part of the data user in terms of its reliability. Data will be reduced, reviewed, and reported as described in the laboratory QA plan.

Data reduction, review, and reporting activities performed by the laboratory are summarized below:

- Raw data are produced by the analyst who has primary responsibility for the accuracy and completeness of the data. All data will be generated and reduced following the QAPP defined methods and implementing laboratory SOP protocols.

- Level 1 technical data review is completed relative to an established set of guidelines by a peer analyst. The review shall ensure the completeness and correctness of the data while assuring all method QC measures have been implemented and were within appropriate criteria. Items to be reviewed include: preparation logs, analysis runs, methodology, results quality control results, internal QC checks, checklists and sign off sheets.

- Level 2 technical review is completed by the area supervisor or data review specialist. This reviews the data for attainment of QC criteria as outlined in the established methods and for overall reasonableness. It will ensure all calibration and QC data are in compliance, qualitative identification of compounds is correct, quantitative calculations are correct, and check at least 10 percent of the data calculations. This review shall document that the data package is complete and ready for reporting and archival.

- Upon acceptance of the raw data by the area supervisor, the report is generated and sent to the Laboratory Project Manager or QA representative for Level 3 administrative data review. This total overview review will ensure consistency and compliance with all laboratory instructions, the laboratory QA plan, the project laboratory SOW, and the project QAPP.

- The Laboraory Project Manager will complete a thorough review of all reports.

- Final reports will be generated and signed by the Laboratory Project Manager.

- Data packages, in Contract Laboratory Program (CLP) format, will then be delivered to the Contractor for data validation.

The data review process will include identification of any out-of-control data points and data omissions, as well as interactions with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. The laboratory will provide flagged data to include such items as:

- Concentration below required detection limit
- Estimated concentration due to poor spike recovery
- Concentration of chemical also found in laboratory blank

The laboratory will prepare and retain full analytical and QC documentation for the project. Such retained documentation will be both hard (paper) copy and electronic storage media (e.g., magnetic tape) as dictated by the analytical methodologies employed. As needed, the laboratory will supply hard copies of the retained information.

The laboratory will provide the following information to the Contractor in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis
- Tabulated results of inorganic, organic, and miscellaneous parameters identified and quantified
- Analytical results for QC sample spikes, sample duplicates, initial and continuous calibration verifications of standards and blanks, standard procedural blanks, LCSs, etc.
- Associated raw data to support the tabulated results for samples and QA/QC
- Tabulation of instrument detection limits determined in pure water.

13.2 Data Validation

Data validation is the systematic review process performed to ensure that the precision and accuracy of the analytical data are adequate for their intended use.

13.2.1 Data Validation Approach

The greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement. Therefore, analytical data validation will be performed only to the level necessary to minimize the potential of using false positive or false negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected compounds). This approach is consistent with the DQOs for the project, with the analytical methods, and for determining contaminants of concern and calculating risk.

Samples will be analyzed through use of standard analytical methods. Definitive data will be reported consistent with the deliverables identified in Section 13.1.2 and Table 13-1. This report content is consistent with what is understood as an EPA **Level IV** deliverable (data forms including laboratory QC, and raw sample data including calibration information). Definitive data will then be validated through the review process presented in Section 13.2.2 and qualified using guidelines established by the analytical method. DQOs identified in Section 3.0 and method-

specified criteria will be validated. An additional copy of the comprehensive analytical information will be retained by the subcontract laboratory.

13.2.2 Primary Data Validation Categories

Validation will be performed by comparing the contents of the complete data package (raw data, sample results and QA/QC results) to the requirements established both in the requested analytical methods and the criteria presented in this QAPP. The Contractor Validation support staff will be responsible for these activities. The protocols for analytical data validation are presented in:

- SW-846 Analytical Method Requirements
- EPA CLP National Functional Guidelines for Organic Data Review (EPA 1994b)
- EPA CLP National Functional Guidelines for Inorganic Data Review (EPA 1994c)

The data will be validated using the processes and procedures provided in the National Functional Guidelines, but the guidelines used for control, will be the criteria established and presented within the SW-846 methods.

- **Holding Times** - Evaluation of holding times ascertains the validity of results based on the length of time from sample collection to sample preparation or sample analysis. Verification of sample preservation must be confirmed and accounted for in the evaluation of sample holding times. The evaluation of holding times is essential to establishing sample integrity and representativeness. Concerns regarding physical, chemical, or biochemical alteration of analyte concentrations can be eliminated or qualified through this evaluation.

- **Blanks** - The assessment of blank analyses is performed to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks applies to any blank associated with the samples, including field, trip, equipment, and method blanks. Contamination during sampling or analysis, if not discovered, results in false-positive data. Blanks will be evaluated against reporting/quantitation limit goals (refer to Tables 7-1, 7-3, 7-5, and 7-7). Analytical method blanks should be below 2× these levels. Field, trip, and equipment rinsate blanks will be evaluated against 5× these levels for most analytes and 10× these levels for common laboratory solvent analytes.

- **Laboratory Control Samples** - The LCS serves as a monitor of the overall performance of the analytical process, including sample preparation, for a given set of samples. Evaluation of this standard provides confidence in or allows qualification of results based on a measurement of process control during each sample analysis.

- **Surrogate Recovery** - System monitoring compounds are added to every sample, blank, matrix spike, MS, MSD, and standard. They are used to evaluate extraction, cleanup, and analytical efficiency by measuring recovery on a sample-specific basis. Poor system performance as indicated by low surrogate recoveries is one of the most common reasons for data qualification. Evaluation of surrogate recovery is critical to the provision of reliable sample-specific analytical results.

- **Internal Standards** - Internal standards are utilized to evaluate and compensate for sample-specific influences on the analyte quantification. They are evaluated to determine if data require qualification due to excessive variation in acceptable internal standard quantitative or qualitative performance measures. For example, a decrease or increase in internal standard area counts for organic compounds may reflect a change in sensitivity that can be attributed to the sample matrix. Because quantitative determination of analytes is based on the use of internal standards, evaluation is critical to the provision of reliable analytical results.

- **Furnace Atomic Absorption Quality Control** - Duplicate injections and furnace post-digestion spikes are evaluated to establish precision and accuracy of individual analytical determinations. Because of the nature of the furnace atomic absorption technique and because of the detailed decision tree and analysis scheme required for quantitation of the elements, evaluation of the QC is critical to ensuring reliable analytical results.

- **Calibration** - The purpose of initial and continuing calibration verification analyses is to verify the linear dynamic range and stability of instrument response. Relative instrument response is used to quantitate the analyte results. If the relative response factor is outside acceptable limits, the data quantification is uncertain and requires appropriate qualification.

- **Sample Reanalysis** - When instrument performance-monitoring standards indicate an analysis is out of control, the laboratory is required to reanalyze the sample. If the reanalysis does not solve the problem (i.e., surrogate compound recoveries are outside the limits for both analyses), the laboratory is required to submit data from both analyses. An independent review is required to determine which is the appropriate sample result.

- **Secondary Dilutions** - When the concentration of any analyte in any sample exceeds the initial calibration range, a new aliquot of that sample must be diluted and reanalyzed. The laboratory is required to report data from both analyses. When this occurs, an independent review of the data is required to determine the appropriate results to be used for that sample. An evaluation of each analyte exceeding the calibration range must be made, including a review of the dilution analysis performed. Results chosen in this

situation may be a combination of both the original results (i.e., analytes within initial calibration range) and the secondary dilution results.

- **Raw Data (inc. Chromatograms and Intensity/Absorbance Readings)** - Raw data will be used to assess the qualitative and quantitative assumptions and decisions made by the laboratory and determine whether the decisions made within the laboratory are substantiatible from a third party position. Retention times and identifications of tentatively identified compounds are verified.

- **Laboratory Case Narratives** - Analytical laboratory case narratives are reviewed for specific information concerning the analytical process. This information is used to direct the data validator to potential problems with the data.

13.3 Data Reporting

All data generated for the project will be provided both hardcopy and electronically formatted in a database format selected by the Contractor. The laboratory will be required to confirm sample receipt and log-in information. The laboratory will return a copy of the completed COC and confirmation of the laboratory's analytical log-in to the Contractor within 24 hours of sample receipt.

The subcontract analytical laboratory will prepare and deliver a full copy of an analytical data package similar to that required by CLP. The lab is required to retain a full copy of the analytical and QC documentation. Such retained documentation will include all hard copies and other storage media (e.g., magnetic tape). As needed, the subcontract analytical laboratory will make available all retained analytical data information.

The data are required to be formatted in the database format to facilitate electronic data entry, review, and evaluation. The electronic data set will be transferred automatically into the database. Following the transfer, the data set will be validated to an equivalent EPA Level III validation review by the validation module. The module will provide an error report which includes data flags in accordance with the above-referenced protocols. The report will be accompanied with additional comments of the Data Validation Team. The associated data flags will include such items as: (1) estimated concentration below-required reporting limit; (2) estimated concentration due to poor calibration, internal standard, or surrogate recoveries; (3) estimated concentration due to poor spike recovery; and (4) estimated concentration of chemical that was also determined in the laboratory blank.

After the electronic validation has been performed, an EPA Level IV validation on a minimum of 10% of the data will be performed by qualified chemists. Flags signifying the usability of data will be noted and entered into an analytical data base. Deficiencies in data deliverables will be corrected through direct communication with the field or laboratory, generating immediate response and resolution. All significant data discrepancies noted during the validation process will documented through NCRs, which are sent to the laboratory for clarification and correction.

Decisions to repeat sample collection and analyses may be made by the Contractor Project Manager and the Project/Program Chemist based on the extent of the deficiencies and their importance in the overall context of the project.

Data assessment will be accomplished by the joint efforts of the data validator, the Program/Project Chemist and the Project Manager. Data assessment by data management will be based on the criteria that the sample was properly collected and handled according to the FSP and QAPP. An evaluation of data accuracy, precision, sensitivity and completeness, based on criteria presented in this QAPP, will be performed by a data assessor and presented in the QCSR. This data quality assessment will indicate that data are: (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to excessive out-of-control QC results.

Project investigation data sets will be available for controlled access by the Contractor Database Manager and other authorized personnel. Each data set will be incorporated into investigation reports as required.

13.4 Data Turnaround Time Requirements

The turnaround time for analytical deliverables for the Building 3 sampling effort is 14 days. However, there may be instances where a fast turnaround is needed. Sufficient notification time will be provided prior to decreasing the turnaround time.

14.0 Performance and System Audits

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FSP and QAPP. Audits of laboratory activities will include both internal and external audits.

14.1 External Laboratory Audits

The USACE HTRW CX conducts on-site audits and validates laboratories on a regular basis. These USACE independent on-site systems audits in conjunction with performance evaluation samples (performance audits) qualify laboratories to perform USACE environmental analysis every 18 months.

These system audits include examining laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, etc. Performance audits consist of sending performance evaluation samples to USACE laboratories for on-going assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated by USACE HTRW CX to ensure that laboratories maintain an acceptable performance.

14.2 Internal Laboratory Audits

Internal performance and system audits of laboratories will be conducted by the Laboratory QA Officer as directed in the laboratory QA plan. These system audits will include examination of laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, etc. Internal performance audits are also conducted on a regular basis. Single-blind performance samples are prepared and submitted along with project samples to the laboratory for analysis. The Laboratory QA Officer will evaluate the analytical results of these single-blind performance samples to ensure that the laboratory maintains acceptable performance.

15.0 QA Reports and Documentation

This section describes the primary quality assurance reports to be prepared by the Contractor and submitted to USACE project management.

15.1 Daily Chemical Data Reports

During field activities, the Contractor will prepare Daily Quality Control Reports (DQCRs) as described in the FSP. In addition to the item specified in the FSP, a daily analytical data report will be included as an attachment to the DQCR. This report will present tabulated analytical results for data that was received since the prior DQCR was submitted to USACE.

15.2 Laboratory Quality Assurance Reports

Each laboratory will provide LORs and analytical QC summary statements (case narratives) with each data package. All COC forms will be compared with samples received by the laboratory and a LOR will be prepared and sent to the Contractor describing any differences in the COC forms and the sample labels or tags. All deviations will be identified on the receiving report such as broken or otherwise damaged containers. This report will be forwarded to the Contractor within 24 hours of sample receipt and will include the following: a signed copy of the COC form; itemized sample numbers; laboratory sample numbers; cooler temperature upon receipt; and itemization of analyses to be performed. Summary QC statements will accompany analytical results as they are reported by the laboratory in the form of case narratives for each sample delivery group.

15.3 Quality Control Summary Reports

At the conclusion of field investigation activities and laboratory analysis, the Contractor, in addition to any review conducted by the laboratory, will perform its own validation of the submitted data. This activity will include assignment of flags to data, documentation of the reason(s) for the assignments, and description of any other data discrepancies. The Contractor will then prepare a Quality Control Summary Report (QCSR), which will be included as an appendix to the final report. This report will be submitted to the CENWK Project Manager as determined by the project schedule. The contents of the QCSR will include data validation documentation and discussion of all data that may have been compromised or influenced by aberrations in the sampling and analytical processes. Both field and laboratory QC activities will be summarized, and all DQCR information will be consolidated. Problems encountered, corrective actions taken, and their impact on project DQOs will be determined.

The following are examples of elements to be included in the QCSR, as appropriate:

- Laboratory QC evaluation and summary of the data quality for each analytical type and matrix. Part of the accuracy, precision, and sensitivity summarized in the data quality assessment.
- Field QC evaluation and summary of data quality relative to data useability. Part of the accuracy, precision, and sensitivity summarized in the data quality assessment.
- Overall data assessment and usability evaluation.
- DCQCR consolidation and summary.
- Summary of lessons learned during project implementation.

Specific elements to be evaluated within the QCSR include the following:

- Sample results
- Field and laboratory blank results
- Laboratory control sample percent recovery (method dependent)
- Sample matrix spike percent recovery (method dependent)
- Matrix spike/matrix spike duplicate or sample duplicate RPD (method dependent)
- Analytical holding times
- Surrogate recovery, when appropriate.

15.4 Field Work Variances

Any departures from approved plans will receive prior approval from the CENWK Project Manager and will be documented via Field Work Variances (FWVs) as discussed in Section 9.3 of the FSP. FWVs will be incorporated into the project evidence file.

15.5 Project Evidence Files

The Contractor will maintain custody of the project evidence file and will maintain the contents of files for this project, including all relevant records, reports, logs, field logbooks, pictures, subcontractor reports, correspondence, and COC forms, until this information is transferred to the CENWK Project Manager. These files will be stored under custody of the Contractor Project Manager. The analytical laboratory will retain all original analytical raw data information (both hard copy and electronic) in a secure, limited access area and under custody of the laboratory Project Manager.

16.0 References

ASTM (American Society of Testing and Materials). 1996. Annual Book of ASTM Standards, Volume 04.08, Soil and Rock.

EPA (U. S. Environmental Protection Agency) 1985. NEIC Policies and Procedures, EPA-300/9-78DDI-R, Revised June.

EPA 1991. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QA/R5, revised October

EPA 1993a. Data Quality Objectives Process, EPA-540-R-93-071, September.

EPA 1993b. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, Revision 1, Update 1.

EPA 1994a. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, January.

EPA 1994b. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-94/012, February.

EPA 1994c. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94/013, February.

USACE (U. S. Army Corps of Engineers) 1994. Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3, September.

USACE (U. S. Army Corps of Engineers) 1998. Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities, ER 1110-1-263, April.

Tables

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Table 3-1

Data Quality Objectives Design Summary

Project Objective	Data Needs	Analytes of Interest	DQO Statements
Identify areas and volumes of contamination in Building 3 that will be included in a subsequent remedial action.	Horizontal and vertical extent of PCB contamination in concrete floors, columns and wallsat concentrations that are at or exceeding the action level	PCBs	Collect data of sufficient quality to detect PCB concentrations of 12.5 ppm. Collect data of sufficient quantity to identify areas within the building exceeding 50 ppm action level.
Characterize Chip Chute waste pile for eventual removal and disposal.	Concentrations of PCBs and RCRA hazardous waste constituents.	PCBs Metals SVOCs	Collect data of sufficient quality to detect PCB concentrations at 12.5 ppm or greater and metals and SVOCs at RCRA TCLP limits. Collect data of sufficient quantity to be representative of waste pile material to be disposed.
Characterize Building 3 structural materials for subsequent off-site waste disposal during remediation.	Concentrations of PCBs and RCRA hazardous waste constituents.	PCBs Metals SVOCs	Collect data of sufficient quality to detect PCB concentrations at 12.5 ppm or greater and metals and SVOCs at RCRA TCLP limits. Collect data of sufficient quantity to be representative of building material to potentially be disposed.
Characterize soils beneath/adjacent to Chip Chute Area for subsequent disposal (if necessary) during remediation.	Concentrations of PCBs and RCRA hazardous waste constituents.	PCBs Metals SVOCs	Collect data of sufficient quality to detect PCB concentrations at 12.5 ppm or greater and metals and SVOCs at RCRA TCLP limits. Collect data of sufficient quantity to be representative of soil to potentially be disposed.
Determine the chemical composition of Building 3 materials for assessing personnel exposure and safety concerns during remediation.	Maximum concentration of contaminants (PCBs, etc.) expected to be present in building materials, and thus, present in dust generated during remediation activities (i.e. demolition).	PCBs Metals SVOCs	Collect data of sufficient quality to detect PCBs, metals, and SVOCs at concentrations at or greater than OSHA permissible exposure limits. Collect data of sufficient quantity to identify maximum contaminant levels to be encountered during remediation.
Characterize IDW (decontamination water) to determine proper disposal methods.	Representative concentrations of PCBs and RCRA hazardous waste constituents.	PCBs Metals SVOCs	Collect data of sufficient quality to detect contaminant concentrations at least equivalent to water quality standards. (For PCBs – 0.5 µg/L). Collect data of sufficient quantity to be representative of decontamination water to be disposed or discharged to POTW (if water quality standards are met).

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Table 4–1

Summary of Sampling and Analysis Program

Sampling Purpose	Media Type	Analytical Parameters	SW-846 Prep/Anal. Methods	Est. Number of Primary Samples*
PCB Identification	Concrete	PCBs	8082	592 (Composite - Floor) 78 (Discrete – Floor) 163 (Discrete – Columns) 6 (Discrete – Walls)
	Soil	PCBs	8082	26
	Waste Pile	PCBs	8082	2
Remediation Waste Characterization	Concrete	TCLP SVOCs	1311/3580A/8270C	7
		TCLP Metals	1311/6010B 1311/7470A	
	Soil	TCLP SVOCs	1311/3580A/8270C	2
		TCLP Metals	1311/6010B 1311/7470A	
	Waste Pile	TCLP SVOCs	1311/3580A/8270C	1
		TCLP Metals	1311/6010B 1311/7470A	
Health and Safety Characterization	Concrete	Total SVOCs	3540C/8270C	5
		Total Metals	3050B/6010B 7471A/6010B	
IDW Characterization	Water	PCBs	8082	5 est.
		Total SVOCs	625/3510C/8270C	
		Total Metals	3010A/6010B 7470A/6010B 3005A/6010B	

* Excluding QA/QC Samples

Table 5-1
Container, Sample Volume, Preservation and Holding Time Requirements for Concrete Samples

Analytical Group	Container(s)	Minimum Sample Size	Preservative	Holding Time
PCBs	One 4-oz glass jar	10 g	Cool, 4±2°C	7 days
Total SVOCs	One 4-oz glass jar with Teflon®-lined cap	50 g	Cool, 4±2°C	7 days
TCLP SVOCs	One 8-oz glass jar with Teflon®-lined cap	200 g	Cool, 4±2°C	14 days
Total Metals	One 4-oz glass jar	10 g	Cool, 4±2°C	180 days; 28 days for Hg
TCLP Metals	One 8-oz glass jar	200 g	Cool, 4±2°C	14 days

Note: For every 20 field samples, and if the laboratory requires the extra volume to analyze MS/MSD samples, the minimum required sample volume will be tripled.

Table 5-2

Container, Sample Volume, Preservation, and Holding Time Requirements for Soil and Waste Pile Samples

Analytical Group	Container(s)	Minimum Sample Size	Preservative	Holding Time
PCBs	One 4-oz glass jar	125 g	Cool, 4±2°C	7 days
Total SVOCs	One 4-oz glass jar with Teflon®-lined cap	50 g	Cool, 4±2°C	7 days
TCLP SVOCs	One 8-oz glass jar with Teflon®-lined cap	200 g	Cool, 4±2°C	14 days
Total Metals	One 4-oz glass jar	10 g	Cool, 4±2°C	180 days; 28 days for Hg
TCLP Metals	One 8-oz glass jar	200 g	Cool, 4±2°C	14 days

Note: For every 20 field samples, and if the laboratory requires the extra volume to analyze MS/MSD samples, the minimum required sample volume will be tripled.

Table 5-3

Container, Sample Volume, Preservation, and Holding Time Requirements for Water Samples

Analytical Group	Container(s)	Minimum Sample Size	Preservative	Holding Time
PCBs	Two 1-L amber glass jar with Teflon®-lined cap	2,000 ml	Cool, 4±2°C	7 days
Total SVOCs	Two 1-L or 1 ½-gal. amber glass bottle with Teflon®-lined cap	2,000 mL	Cool, 4±2°C	7 days
Total Metals	One 1-L plastic or glass container	300 mL	HNO_3 to pH ≤2; Cool, 4±2°C	180 days; 28 days for Hg

Table 6-1
Summary of Field QA/QC Samples

Collection Frequency of Field QA/QC Samples

QA/QC Sample Type	Frequency of Collection
Field Duplicates	10 % of total field samples
USACE Split Samples	10 % of total field samples
MS/MSD Samples	5 % of total field samples
Equipment Rinsate Blanks	5% of total field samples

Estimated Number of Field QA/QC Samples

Sampling Purpose	Media Type	Analytical Parameters	No. of Primary Samples	No. of Field Duplicates	No. of USACE Splits	No. of Equip. Rinsates*	No. of MS/MSD **
PCB Identification	Concrete	PCBs	839	84	84	42	42
	Soil	PCBs	26	3	3	2	2
	Waste Pile	PCBs	2	1	1	1	1
Remediation Waste Characterization	Concrete	TCLP SVOCs TCLP Metals	7	1	1	0	0
	Soil	TCLP SVOCs TCLP Metals	2	0	0	0	0
	Waste Pile	TCLP SVOCs TCLP Metals	1	0	0	0	0
Health and Safety Characterization	Concrete	Total SVOCs Total Metals	5	1	1	0	0
TOTALS			**882**	**90**	**90**	**45**	**45**

* Equipment rinsates are not necessary for remediation waste characterization samples and health and safety characterization samples since they are collected at the same time as the PCB samples (using the same equipment), or they are collected from the excess volume from PCB samples (using no field equipment).

** If additional sample volume is needed by analytical laboratory.

Table 7-1

Reporting Limits for Method 8082 (PCBs)

Analyte	Concrete, Soil, Waste		Water	
	RL*	Units	RL	Units
PCB – 1016	1	mg/kg	0.5	µg/L
PCB – 1221	1	mg/kg	0.5	µg/L
PCB – 1232	1	mg/kg	0.5	µg/L
PCB – 1242	1	mg/kg	0.5	µg/L
PCB – 1248	1	mg/kg	0.5	µg/L
PCB – 1254	1	mg/kg	0.5	µg/L
PCB - 1260	1	mg/kg	0.5	µg/L

* Project-specific RL – provides a factor of safety to ensure that minimum sensitivity does not exceed 12.5 ppm.

Table 7-2
Precision and Accuracy Limits for Method 8082 (PCBs)

Analyte	Concrete, Soil, Waste		Water	
	Accuracy (%Recovery)	Presision (RPD)	Accuracy (%Recovery)	Precision (RPD)
PCB - 1016	60 – 130	≤20	55 –115	≤20
PCB - 1260	55 - 145	≤20	60 -120	≤25

Table 7-3
Reporting Limits for Method 8270C (SVOCs)

Analyte	Water		Soil	
	RL	Units	RL	Units
1,2,4-Trichlorobenzene	10	µg/L	330	µg/kg
1,2-Dichlorobenzene	10	µg/L	330	µg/kg
1,3-Dichlorobenzene	10	µg/L	330	µg/kg
1,4-Dichlorobenzene	10	µg/L	330	µg/kg
2,4-Dinitrotoluene	10	µg/L	330	µg/kg
2,6-Dinitrotoluene	10	µg/L	330	µg/kg
2-Chloronaphthalene	10	µg/L	330	µg/kg
2-Methylnaphthalene	10	µg/L	330	µg/kg
2-Nitroaniline	50	µg/L	1700	µg/kg
3-Nitroaniline	50	µg/L	1700	µg/kg
3,3'-Dichlorobenzidine	20	µg/L	700	µg/kg
3=4-Bromophenyl phenyl ether	10	µg/L	330	µg/kg
4-Chloroaniline	20	µg/L	700	µg/kg
4-Chlorophenyl phenyl ether	10	µg/L	330	µg/kg
4-Nitroaniline	50	µg/L	1700	µg/kg
Acenaphthylene	10	µg/L	330	µg/kg
Acenaphthene	10	µg/L	330	µg/kg
Anthracene	10	µg/L	330	µg/kg
Benz (a) anthracene	10	µg/L	330	µg/kg
Benzo (a) pyrene	10	µg/L	330	µg/kg
Benzo (b) fluoranthene	10	µg/L	330	µg/kg
Benzo (g,h,i) perylene	10	µg/L	330	µg/kg
Benzyl alcohol	20	µg/L	700	µg/kg
Bis (2-chlorethoxy) methane	10	µg/L	330	µg/kg
Bis (2-chlorothyl) ether	10	µg/L	330	µg/kg
Bis (2-chloroisopropyl) ether	10	µg/L	330	µg/kg
Bis (2-ethylhexyl) phthalate	10	µg/L	330	µg/kg

Analyte	Water		Soil	
	RL	Units	RL	Units
Butyl benzylphthalate	10	µg/L	330	µg/kg
Chrysene	10	µg/L	330	µg/kg
Di-n-butylphthalate	10	µg/L	330	µg/kg
Di-n-octylphthalate	10	µg/L	330	µg/kg
Dibenz (a,h) anthracene	10	µg/L	330	µg/kg
Dibenzofuran	10	µg/L	330	µg/kg
Diethyl phthalate	10	µg/L	330	µg/kg
Dimethyl phthalate	10	µg/L	330	µg/kg
Fluoranthene	10	µg/L	330	µg/kg
Fluorene	10	µg/L	330	µg/kg
Hexachlorobenzene	10	µg/L	330	µg/kg
Hexachlorobutadiene	10	µg/L	330	µg/kg
Hexachlorocyclopentadiene	10	µg/L	330	µg/kg
Hexachloroethane	10	µg/L	330	µg/kg
Indeno (1,2,3-cd) pyrene	10	µg/L	330	µg/kg
Isophorone	10	µg/L	330	µg/kg
n-Nitrosodimethylamine	10	µg/L	330	µg/kg
n-Nitrosodiphenylamine	10	µg/L	330	µg/kg
n-Nitrosodi-n-propylamine	10	µg/L	330	µg/kg
Naphthalene	10	µg/L	330	µg/kg
Nitrobenzene	10	µg/L	330	µg/kg
Phenanthrene	10	µg/L	330	µg/kg
Pyrene	10	µg/L	330	µg/kg

Table 7-4
Precision and Accuracy Limits for Method 8270C (SVOCs)

Analyte	Water		Soil	
Base/Neutral Fraction Compounds	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)	Precision (RDP)
1,2,4-Trichlorobenzene	40-145	≤20	30-150	≤30
1,2-Dichlorobenzene	40-155	≤20	30-130	≤30
1,3-Dichlorobenzene	35-125	≤20	35-135	≤30
1,4-Dichlorobenzene	30-125	≤20	25-135	≤30
2,4-Dinitrotoluene	35-140	≤20	25-149	≤30
2,6-Dinitrotoluene	50-125	≤20	40-135	≤30
2-Chloronaphthalene	55-125	≤20	45-135	≤30
2-Methylnaphthalene	40-125	≤20	30-135	≤30
2-Nitroaniline	45-125	≤20	45-135	≤30
3-Nitroaniline	45-125	≤20	25-175	≤30
3,3'-Dichlorobenzidine	25-175	≤20	25-175	≤30
4-Bromophenyl phenyl ether	50-125	≤20	40-135	≤30
4-Chloroaniline	40-135	≤20	35-135	≤30
4-Chlorophenyl phenyl ether	50-130	≤20	40-140	≤30
4-Nitroaniline	35-140	≤20	25-150	≤30
Acenaphthylene	45-125	≤20	35-135	≤30
Acenaphthene	45-155	≤20	35-135	≤30
Anthracene	40-165	≤20	35-175	≤30
Benz (a) anthracene	50-135	≤20	40-140	≤30
Benzo (a) pyrene	40-125	≤20	30-130	≤30
Benzo (b) fluoranthene	35-125	≤20	25-135	≤30
Benzo (g,h,i) perylene	30-150	≤20	25-155	≤30
Benzyl alcohol	30-125	≤20	25-135	≤30
Bis (2-chlorethoxy) methane	45-125	≤20	35-135	≤30
Bis (2-chlorothyl) ether	40-125	≤20	30-135	≤30

Analyte Base/Neutral Fraction Compounds	Water		Soil	
	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)	Precision (RDP)
Bis (2-chloroisopropyl) ether	30-135	≤20	25-175	≤30
Bis (2-ethylhexyl) phthalate	30-130	≤20	25-135	≤30
Butyl benzylphthalate	20-125	≤20	25-135	≤30
Chrysene	55-135	≤20	45-140	≤30
Di-n-butylphthalate	30-125	≤20	25-135	≤30
Di-n-octylphthalate	35-130	≤20	25-135	≤30
Dibenz (a,h) anthracene	50-125	≤20	40-135	≤30
Dibenzofuran	50-125	≤20	40-135	≤30
Diethyl phthalate	35-125	≤20	25-135	≤30
Dimethyl phthalate	25-125	≤20	25-175	≤30
Fluoranthene	45-125	≤20	35-135	≤30
Fluorene	45-135	≤20	35-145	≤30
Hexachlorobenzene	45-135	≤20	35-140	≤30
Hexachlorobutadiene	25-125	≤20	25-135	≤30
Hexachlorocyclopentadiene	20-125	≤20	30-135	≤30
Hexachloroethane	25-150	≤20	25-165	≤30
Indeno (1,2,3-cd) pyrene	25-160	≤20	25-175	≤30
Isophorone	25-175	≤20	25-175	≤30
n-Nitrosodimethylamine	25-125	≤20	25-175	≤30
n-Nitrosodiphenylamine	25-125	≤20	25-135	≤30
n-Nitrosodi-n-propylamine	35-125	≤20	25-135	≤30
Naphthalene	45-125	≤20	40-135	≤30
Nitrobenzene	40-130	≤20	35-140	≤30
Phenanthrene	50-120	≤20	40-135	≤30
Pyrene	45-145	≤20	35-145	≤30

Table 7-5
Reporting Limits for Method 6010B (Metals)

Analyte	Water		Soil	
	RL	Units	RL	Units
Aluminum	200	µg/L	20	mg/kg
Antimony	50	µg/L	5	mg/kg
Arsenic	10	µg/L	1	mg/kg
Barium	50	µg/L	5	mg/kg
Beryllium	5	µg/L	0.5	mg/kg
Cadmium	5	µg/L	0.5	mg/kg
Calcium	1000	µg/L	100	mg/kg
Chromium	10	µg/L	1	mg/kg
Cobalt	10	µg/L	1	mg/kg
Copper	10	µg/L	1	mg/kg
Iron	100	µg/L	10	mg/kg
Lead	3	µg/L	0.3	mg/kg
Magnesium	100	µg/L	10	mg/kg
Manganese	5	µg/L	0.5	mg/kg
Nickel	10	µg/L	1	mg/kg
Potassium	500	µg/L	50	mg/kg
Selenium	10	µg/L	1	mg/kg
Silver	10	µg/L	1	mg/kg
Sodium	1000	µg/L	100	mg/kg
Thallium	10	µg/L	1	mg/kg
Vanadium	10	µg/L	1	mg/kg
Zinc	10	µg/L	1	mg/kg

Table 7-6
Precision and Accuracy Limits for Method 6010B (Metals)

Analyte	Water		Soil	
	Accuracy (%Recovery)	Presision (RPD)	Accuracy (%Recovery)	Precision (RPD)
Aluminum	75-125	±20	75-125	±35
Antimony	75-125	±20	75-125	±35
Arsenic	75-125	±20	75-125	±35
Barium	75-125	±20	75-125	±35
Beryllium	75-125	±20	75-125	±35
Cadmium	75-125	±20	75-125	±35
Calcium	75-125	±20	75-125	±35
Chromium	75-125	±20	75-125	±35
Copper	75-125	±20	75-125	±35
Iron	75-125	±20	75-125	±35
Lead	75-125	±20	75-125	±35
Magnesium	75-125	±20	75-125	±35
Manganese	75-125	±20	75-125	±35
Nickel	75-125	±20	75-125	±35
Potassium	75-125	±20	75-125	±35
Selenium	75-125	±20	75-125	±35
Silver	75-125	±20	75-125	±35
Sodium	75-125	±20	75-125	±35
Thallium	75-125	±20	75-125	±35
Vanadium	75-125	±20	75-125	±35
Zinc	75-125	±20	75-125	±35

Table 7-7

Reporting Limits and Precision and Accuracy Limits for Method 7470A/7471A (Mercury)

Reporting Limits

Analyte	Water (7470A)		Soil (7471A)	
	RL	Units	RL	Units
Mercury	1.0	µg/L	0.1	mg/kg

Precision and Accuracy Limits

Analyte	Water (7470A)		Soil (7471A)	
	Accuracy (%Recovery)	Precision (RPD)	Accuracy (%Recovery)	Precision (RPD)
Mercury	70-130	≤20	70-130	≤35

Table 8-1

Calibration and QC Check Requirements for Method 8082 (PCBs)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Five-point initial calibration for AR-1016 and AR-1260, plus single standard of each of the remaining five Aroclors. For Congener analysis, calibrate for all congeners with five-level standard curve	Prior to sample analysis	Linear - mean RSD for all analytes #20% with no individual analyte >30% RSD Linear-least squares regression r∃0.995 Acceptable Response Factor for single standard compound	Correct problem, then repeat initial calibration
Peak Quantitation	For each Aroclor	Use of a minimum of three peaks (preferably five) peaks per compound for quantitation	The mean response or Calibration Factor, the Standard Deviation, and %Relative Standard Deviation must meet Method 8000 requirements
Retention time window calculated for each analyte		Chosen appropriately to alleviate false positive and false negative results	Correct problem, then reanalyze all samples analyzed since the last retention time check
Initial Calibration Verification	Every 12 hours following initial calibration and before any sample analysis	All analytes within ∀15% of expected value.	Correct problem, then repeat initial calibration
Continuing Calibration Verification	After every 10 samples and at the end of the analysis sequence	All analytes within ∀15% of expected value (85% - 115% R)	Correct problem then repeat initial calibration
Method Blank (MB)	One MB per	No analytes detected	Qualify all affected

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
	analytical batch; not to exceed 1 MB per twenty field samples	∃Reporting Limit	compounds for samples in analytical batch
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	All spiked analytes recovery within 80-120% of certified value	Reprep LCS and all samples in the affected analytical batch
Matrix Spike (MS) / Matrix Spike Duplicate (MSD)	One MS/MSD set per 20 client samples	Sample spiked minimally with AR-1016 and- 1260 and recovered within lab established control limits	Qualify all samples in analytical batch estimated for out-of control analytes
Duplicate Sample Analysis	One duplicate sample analysis per set of 20 client field samples.	All positive detects analytes should agree within ∀25% D	Qualify the original and duplicate hits as estimated; out-of-control
Second-column Confirmation	100% for all positive results	Identical as for initial or primary column analysis	Identical as for initial or primary column analysis
Surrogate Spikes	Minimum one added to every sample, blank, QC, and std.	Recovered within lab established control limits	Rerun to confirm matrix interference; re-extract if necessary
Internal Standards	Added to every sample and all QC solutions if determination of congeners is performed	Refer to Method 8000 for criteria	

Table 8-2

Calibration and QC Check Requirements for Method 8270C (SVOCs)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Five-point initial calibration for all analytes	Prior to sample analysis	SPCCs average RF ≥0.50 and %RSD for RFs for CCCs ≤30% and one of the below:	Correct problem, then repeat initial calibration
		1) Linear-mean RSD ≤15% for all analytes; no individual analyte _30% RSD	
		2) Linear-least squares regresssion r≥0.995	
		3) Non-linear - COD ≥0.990	
Second-source calibration verification	Once per five-point calibration	All analytes within ±25% of expected results	Correct problem then repeat initial calibration
Retention time window calculated for each analyte	Each Sample	Relative Retention Time (RRT) of the analyte within ±0.06 units of the RRT	Correct problem, then reanalyze all samples analyzed since the last retention time check
Continuing Calibration Verification	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥0.050; and CCCs ≤20% difference or drift	Correct problem then repeat initial calibration

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Internal Standards	6 per each sample	Retention time ±30 seconds from the retention time of the mid-point std. of the ICAL	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of all samples out-of control
		EICP area within -50% to +100% of the ICAL mid point std.	
Method Blank (MB)	One MB per analytical batch	No analytes detected ≥Reporting Limit (RL)	Qualify affected compounds for associated samples with B to indicate blank contamination
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	Recover all spiked compounds within laboratory established control limits	Re-extract entire sample batch and associated QC and rerun
Check of mass spectal ion intensities using DFTPP Tune	Prior to initial calibration and calibration verification	All mass ion abundances as per method 8270C; expanded criteria allowed within CLP protocol	Inspect mass spectrometer and GC for malfunctions; rerun DFTPP and retune hardware
Matrix Spike (MS) / Matrix Spike Duplicate (MSD)	One MS/MSD set per 20 client samples	Recover all spiked compounds within laboratory established control limits	Qualify affected compounds for associated samples to indicate estimated concentrations

Table 8-3

Calibration and QC Check Requirements for Method 6010B (Metals)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial calibration for all analytes consisting of a minimum blank and high standard	Daily prior to sample analysis	None	None
Initial Calibration Verification (second-source)	Daily after initial calibration	All analytes within ±10% of expected results	Correct problem then repeat initial calibration
Calibration Blank	After every calibration verification	No analytes detected ≥Reporting Limit (RL)	Correct problem, then reanalyze calibration blank and previous 10 samples
Calibration Verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	All analytes with ±10% of expected results and RSD of replicate integrations <5%	Repeat calibration and reanalyze all samples since successful calibration
Interference Check Standard (ICS)	At the beginning of the an analytical run	All analytes with ±20% of expected results	Terminate analysis ; correct problem; reanalyze ICS; reanalyze all affected samples
Method Blank (MB)	One MB per analytical batch	No analytes detected ≥Reporting Limit (RL)	None; qualify associated samples according to 5X rule
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	Recover all analytes within 80-120% of true value	Re-digest entire sample for re-analysis of out of control analyte
Matrix Spike (MS) / Matrix Spike Duplicate (MSD)	One MS/MSD set per 20 client samples	Recover all analytes within 75-125% of spoiked	Qualify all associated sample as estimated for out of control

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Duplicate (MSD)	samples	value	analyte
Serial Dilution Test	One sample per sample digestion batch	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition
Post Digestion Spike Addition	When serial dilution test fails.	Recovery within 75-125% of expected results	Correct problem then reanalyze post digestion spike addition

Table 8-4

Calibration and QC Check Requirements for Method 7470A/7471A (Mercury)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Initial multipoint calibration (minimum 5 standards and a blank	Daily prior to sample analysis	Correlation Coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration
Second Source Calibration Verification	Once per initial calibration	Analytes within ±10% of expected results	Correct problem then repeat initial calibration
Calibration Blank	After every calibration verifications	Analytes detected ≥Reporting Limit (RL)	Correct problem, then reanalyze calibration blank and previous 10 samples
Calibration Verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	Analytes with ±20% of expected results	Repeat calibration and reanalyze all samples since successful calibration
Method Blank (MB)	One MB per analytical batch	No analytes detected ≥Reporting Limit (RL)	Qualify associated using the 5X rule for blank contamination
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	Recover within 80-120% of true	Re-digest entire sample batch
Matrix Spike (MS) / Matrix Spike Duplicate (MSD)	One MS/MSD set per 20 client samples	Recover within 70-130% and agree within 20% for waters and 35% for soils	Qualify associated samples' results as estimated

Table 10-1

Summary of Typical Laboratory Preventative Maintenance Procedures

Instrument	Activity	Frequency
Gas Chromatograph / Mass Spectrometer Semivolatile Organic Compounds (GC/MS)	Clean mass spectrometer source	When tuning criteria cannot be achieved
	Change septum	Daily
	Change liners	Daily
	Check carrier gas	Daily
	Change carrier gas	When pressure ≤500psi
	Change in-line filters	Quarterly, as needed
	Remove first foot of column	To improve chromatography
	Bake out column	To improve chromatography
	Check system for gas leaks	At each column change
	Sylonize injection port liners	Every liner
High Performance Liquid Chromatograph (HPLC)	Check / change degas gases	Daily
	Check / change guard column	Weekly
	Check / replace pre-column frits	Weekly
	Monitor UV lamp intensity	As needed
	Replace Column	As needed
	Check flows	Weekly
Cold Vapor Atomic Absorption Spectrophotomer (CVAAS)	Clean optical windows	Daily
	Check plumbing connections	Daily
	Check gases	Daily
	Change drying tube	Daily
	Change tubing	Weekly
Inductively Coupled Plasma Optical Emission Spectrometer (ICP or ICPOES)	Check gas flow	Daily
	Clean nebulizer	Weekly
	Check torch	Weekly, or as needed
	Change tubing	Weekly, or as needed
	Check optics	Annual service contract
UV/Visible Spectrophotometer (UV/Vis)	Clean spectrophotometer windows	Daily
	Change spectrophotometer cuvettes	Daily
	Check autosampler and tubing	Daily
	Check filters	Monthly
Ovens	Temperature monitoring	Once daily
Refrigerators	Temperature monitoring	Once daily
Analytical Balances	Check pans and compartment Check alignment and calibration	Prior to use Before every use
	Cleaning/ Service	Semi-anually

Table 12-1

Calculations for Data Quality Indicators

Statistic	Symbol	Formula	Definition	Use
Mean	$\overline{x}$	$\left(\frac{\sum_{i=1}^{n} x_i}{n}\right)$	Measure of central tendency	Used to determine the average value of multiple measurements
Standard Deviation	S	$\sqrt{\left(\frac{\sum (x_i - \overline{x})^2}{n-1}\right)}$	Measure of the relative scatter of the data	Used in calculating variation of measurements
Relative Standard Deviation	RSD	$\left(S/\overline{x}\right)\times 100$	Relative standard deviation adjusts for the magnitude of observations	Used to assess the precision parameter for replicate results
Percent Difference	%D	$\left(\frac{x_1 - x_2}{x_1}\right) \times 100$	Measure of the difference between two observations	Used to assess the accuracy parameter
Relative Percent Difference	RPD	$\left(\frac{x_1 - x_2}{(x_1 + x_2) \div 2}\right) \times 100$	Measure of variability that adjusts for the magnitude of observations	Used to assess the analytical precision of duplicate measurements
Percent Recovery	%R	$\left(\frac{x_{measured}}{x_{true}}\right) \times 100$	Recovery of spiked compounds in control sample (LCS)	Used to assess the accuracy parameter
Percent Recovery	% R	$\frac{(x_s - x_u)}{x_a} \times 100$ where: x_s is the value of the spiked sample, x_u is the value of the unspiked sample, x_a is amount spiked into the sample	Recovery of spiked compounds in the sample matrix	Used to assess matrix effects and precision between the MS and MSD

Table 13-1

Summary of Analytical Data Deliverable Requirements

Method requirements	Deliverables
Requirements for all methods:	
- Holding time information and methods requested	Signed chain-of-custody forms
- Discussion of laboratory analysis, including any laboratory problems	Case narratives
Organics: GC/MS analysis	
- Sample results, including TICs	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- GC/MS tune	CLP Form 5 or equivalent
- GC/MS initial calibration data	CLP Form 6 or equivalent
- GC/MS continuing calibration data	CLP Form 7 or equivalent
- GC/MS internal standard area data	CLP Form 8 or equivalent
Organics: GC analysis	
- Sample results	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- Initial calibration data	CLP Form 6 or equivalent
- If calibration factors are used	A form listing each analyte, the concentration of each standard, the relative calibration factor, the mean calibration factor, and %RSD
- Calibration curve if used	Calibration curve and correlation coefficient
- Continuing calibration data	CLP Form 9 or equivalent
- Positive identification (second column confirmation)	CLP Form 10 or equivalent
Metals	
- Sample results	CLP Form 1 or equivalent
- Initial and continuing calibration	CLP Form 2 or equivalent, dates of analyses and calibration curve, and the correlation coefficient factor
- Method blank	
- ICP interference check sample	CLP Form 3 or equivalent and dates of analyses
- Spike sample recovery	CLP Form 4 or equivalent and dates of analyses
- Postdigestion spike sample recovery for ICP metals	CLP Form 5A or equivalent CLP Form 5B or equivalent

Method requirements	Deliverables
- Postdigestion spike for GFAA	CLP Form 5B or equivalent
- Duplicates	CLP Form 6 or equivalent
- LCS	CLP Form 7 or equivalent that includes acceptable range or window
- Standard additions (when implemented)	CLP Form 8 or equivalent
- Holding times	CLP Form 13 or equivalent
- Run log	CLP Form 14 or equivalent
Wet Chemistry	
- Sample results	Report result
- Matrix spike recovery	%Recovery
- Matrix spike duplicate or duplicate	%Recovery and %RPD
- Method blank	Report results
- Initial calibration	Calibration curve and correlation coefficient
- Continuing calibration check	Recovery and % difference
- LCS	LCS result and control criteria
- Run log	Copy of run log